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+ XXXIX.—*On the Wings of Birds.* By C. J. SUNDEVALL.

(Plates X., XI.)

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INTRODUCTION.

As the differences in the feather-covering of the wings of birds appear to be of the very greatest significance in the systematic arrangement of that class, which otherwise seems to present so few, or rather no certain, characters for the larger divisions, a somewhat detailed description of them may possess no little interest. People seem not to have supposed, or to have been unwilling to believe, that such apparently accessory parts as feathers could furnish reliable indications of the internal organization of the different groups of birds, which they sought in vain from other organs; at least we can scarcely explain in any other way why the very remarkable differences in the structure of the wings were so long neglected, although they are among the very first which must strike the eye in the external examination of birds. It is, however, a truth that every external part of an animal can furnish equally certain indications of affinity or distinction between species as an internal part of the body, and that in this respect no order of precedence can be established *a priori*. A character certainly does not possess

greater value merely because it is derived from the relations of internal parts, of which the many exceedingly unnatural systematic classifications, founded upon so-called anatomical characters, are a clear proof*.

Thus what is characteristic may just as easily be overlooked in the internal as in the external parts ; but, should it be correctly grasped, every part of an animal's surface or covering ought to furnish characters just as reliable for the animal's affinities as the inner or so-called nobler parts ; for the cause, predetermined in the egg, which makes an animal belong to one or the other class, order, family, species, &c., has continued to act uninterruptedly throughout the whole development upon every part of the animal's body, both external and internal, and has necessarily left behind some impress which may be distinguished from all others. But as different causes must produce different effects, it becomes impossible that any particular part in an animal can be exactly similar to a part in another animal of a different order, genus, &c. From a physiological point of view, indeed, the internal parts may be regarded as more important than the external ; but zoographically we must regard the external parts as possessing an equal if not greater value, because the characters derived from them can be easily recognized and examined in the specimens of natural products which usually occur, which is not the case with those founded upon the internal parts ; and I venture to maintain that only external form-characters ought to be employed in zoographical diagnoses, and also that the external parts always present such characters as express quite clearly the affinities of the species, although these characters may not always lie open to superficial observation. The wing-feathers may therefore furnish just as important characters as any other part of a bird's body, and an accurate knowledge of them may be of the greatest value in ornithology.

* *E. g.* the classifications of the Arachnida from the organs of respiration, the divisions in the class Vermes in accordance with differences in the nervous system, the arrangement of the Gasteropoda according to the branchiæ, &c.

The history of this knowledge is not very extended. It includes in the first place the terminology adopted by Linnæus, which is to be found systematically set forth in 1758 in the 'Systema Naturæ,' ed. x. p. 79, and still more in detail in 1766 in ed. xii. pp. 110–111*.

This terminology is extended and improved by Illiger in his well-known 'Terminologie,' published in 1798 (translated into Swedish by Marklin), and reproduced in the same words in his 'Prodromus Systematis Mammalium et Avium' (1811). There was here no question of anything but a terminology, and therefore scarcely anything was added serving essentially to advance the knowledge of the structure of the wing; merely a heap of new names adopted:—Pteromata, Ptila, Camptorium, &c. Illiger was not sparing of new terms, and adopted without hesitation, besides the necessary ones which ought always to be retained, a great number which are not necessary, and which I must therefore regard as superfluous. Of those which relate to the wings I shall speak hereafter†.

Some subsequent attempts do not properly deal with the structure of the wing in its entirety. This applies to Isidore Geoffroy St.-Hilaire's recently published memoir in his 'Essais de Zoologie générale' (Paris, 1841), in which the terms *obtuse* and *aigüe* (obtuse and acute), with the superadded more exact qualifications *sur* and *sub*, are adopted to indicate that

* "Alæ . . . tectæ pennis, demum *Tectricibus* primis secundisque, positæ ciliatæ *remigibus*, &c. *Remiges primores* x.: 1–4 Digniti, 5–10 Metacarpî; *Secundarii* 10–20 s. 28 Cubiti; nulli vero Brachii; at *Alula* spuria pennis 3 s. 5 Pollici insidet." It is impossible that such a clear and complete description could be given in a briefer form.

† Of course it is not my intention to censure the terminology of this distinguished man, drawn up as it is in a truly classical spirit; but we should, as far as possible, avoid making terminology into a special study, which burdens the memory, and therefore we should follow the prevalent example of the general usages of language, and adopt *termini technici* only for parts or ideas which are never or rarely employed in diagnosis, and not for those in the naming of which we can avail ourselves of the ordinary mathematical terms (which must of course be used in their proper signification) or of other generally known and accepted terms (*e.g.* *margo alæ*, instead of *camptorium*, Illig.).

the first, second, &c. feather is the longest. This adoption of terms in place of definitions may, indeed, be often valuable and useful; but it seems to me unnecessary, for when exactitude is required we must still always say, for example, *the first feather is the longest*, or *the second feather is the longest*, &c., which is certainly more definite than to say *the wing is very acute* (*suraigüe, acutissima*) or merely *acute* (*aigüe, acuta*).

Nitzsch's remarkable work 'System der Pterylographie,' as is well known, threw a new light on the feather-covering of birds in general; but as regards the structure of the wings, we find in it scarcely any statements except as to the number and structure of the remiges. The coverts are noticed only in a few places, and the number or constitution of their series, their presence or absence, distance apart, &c. are, remarkably enough, not mentioned at all.

Those who have seen in the bird's wing merely a flying-machine and studied it in this aspect have had the least influence of all upon our knowledge. It must be remarked that the wing always occurs in birds, but that it is not always an organ of flight.

By a comparison, made about Christmas 1830, of the wings in a freshly killed *Strix bubo* with those of *Emberiza citrinella*, I first obtained a notion of the considerable differences which exist between those organs in different genera. The changed position of many series of feathers and the great difference in the number and length of the coverts especially attracted my attention*. A continued investigation soon showed that these differences were of the greatest importance as external characters for the primary divisions of the class, and as such they were set forth in my "Ornithologiska System," prepared in the year 1834, and printed in the 'Vetenskaps-Akademiens Handlingar' for

* It must be stated that Herr W. v. Wright had about the same time noticed these peculiarities in the wings of birds, of which his remarkably correct figures in the illustrated work 'Skandinaviens Foglar' bear witness. But we did not know of each other's discoveries until some years afterwards.

the year 1835. Nevertheless I had not then grasped the whole importance of these characters as external distinctions between the birds which do or do not possess singing-muscles on the inferior larynx, for I still believed that I found exceptions in the genera *Picus*, *Upupa*, and *Menura*. Later investigations have shown that these genera do not deviate from the general rule, and that the presence or absence of the so-called singing-apparatus is indicated by two dissimilar structures of the wings. After the year 1834 other studies occupied my time, so that this subject did not again come under examination until the report of the statement of Keyserling and Blasius of the (in their opinion) first positive external characters for Song-birds, caused the subject to be again taken up in the zoological "Årsberättelse" of the Academy of Sciences, printed in 1841 (p. 126). As I soon afterwards, in the same year, undertook a journey into foreign countries, I communicated the matter to several individual zoologists, and also to the Meeting of Naturalists at Brunswick. The Transactions of that meeting, however, contain no more than had already been made known in print in 1835. A somewhat more detailed exposition of the subject was first made before the Meeting of Scandinavian Naturalists in Stockholm in 1842, and this is printed in the Transactions of that Meeting (p. 685). In the present paper I venture to give a description of the bird's wing somewhat more in detail.

FIRST CHAPTER.

General Review.

The bird's wing consists of the following parts :—

1. The anterior extremity, namely :—*Humerus* (upper arm, Pl. X. figs. 1, 2, &c., *a*), *cubitus* (forearm, *b*), and *hand* (manus, *c*), which again is composed of the *carpus* (wrist, *v*), *metacarpus* (middle hand, *c*), *first phalange* (*y*) and the *second* (*z*), with the *pollex* (thumb, *d*).

Although it is not my intention here to describe anything but the exterior and its coverings, it may nevertheless be stated in passing that the two bones of the forearm, the *ulna* (fig. 1, *g*) and the *radius* (*b*), are always separate in birds,

and the former the strongest. The *carpus* has only two very small, free bones (*v* and *w*); the others appear to have either entirely disappeared or become coalesced with the following part (at *x*). The large *os metacarpi* (*c*) belonging to the only finger developed has at its base a large tubercle (*x*), which seems to indicate coalescence with a part of the carpus and the metacarpus of the thumb. In some birds this tubercle is produced into a spine (spur) covered with horn; and it always bears on the anterior (radial) side the small *thumb* (*d*), composed only of a single joint. Along the posterior (ulnar) side of the bone lies an *os metacarpi* (between *f* and *v*) of a third finger; but this is amalgamated with the former at the two ends, and only bears at its apex a small phalange (*f*) concealed under the skin. The middle finger consists of two joints (*y* and *z*).

At the base (*h*) the humerus is more or less enclosed between the muscles, so that, although it does not project entirely, as in man, beyond the curvature of the surface of the trunk, it always does so partially ($\frac{2}{3}-\frac{1}{2}$). The *cubitus* and the *hand*, which bear the true wing-feathers, are strongly compressed and flattened in consequence of the form of the bones, as well as of the position of the muscles and structure of the skin.

In the angle behind the humerus the muscles and skin, as in man, form two more or less distinct folds, which bound the *axilla* (fig. 2, *i*); the anterior fold is formed by the pectoral muscles, the posterior one by the back and the margin of the scapular muscles.

In the anterior angle, between the humerus and cubitus the skin does not lie, as usual, closely upon the muscles and bones, but it forms there a large fold (*e*), the *antebrachial fold* (plica antebrachialis). When the wing is folded up, this cutaneous fold would hang loosely down like a bag, if it were not drawn together by a very remarkably constructed elastic sinew, which issues from a muscle in the shoulder (in front of *h*, fig. 6) beside the m. deltoideus, and runs within the whole anterior margin of the fold as far as the carpus, where it spreads out and terminates in the skin.

Along the hinder margin of the cubitus and hand the skin likewise forms a large, but firm and hard fold (*f, g*), in which the large wing-feathers are seated. Indeed it is by the considerable development of the feathers that the skin is drawn out into a fold which surrounds the roots of the feathers.

The differences in the length of the different joints of the wing will be referred to further on, under the head of the *Remiges cubitales*.

2. The wing consists of the feathers which clothe the anterior extremity, in the skin of which they are seated arranged in rows (series) which are parallel to the bones and to the posterior margin of each individual joint.

The feathers are generally directed backwards, so that each series covers that lying immediately behind it (or at least its root). In general there are about the same number of feathers in each series, for they are arranged in *quincunx*, so that each feather is situated in the middle of an interval in the two nearest series. Their points of insertion may therefore form rows in three different ways (see figs. 2, 6); but the feathers themselves form series only in one way, because all those which are placed in the same series are nearly of the same size and nature, while those in different series most frequently differ considerably from each other (see figs. 3, 4, 7, 8). The smallest and softest are placed in front; towards the posterior margin of the wing the feathers increase in size and firmness, so that the quill-feathers which occupy the posterior margin itself are the largest of all. In the enumeration of the series we must therefore necessarily begin with the quill-feathers and call them the *first series*; the second, third, &c. follow in order forwards. The foremost series are so small and indistinct that one can hardly distinguish them unless we proceed in order from the posterior ones.

In each series we must call those feathers *outer* (*externæ*) which are placed nearest to the apex of the wing; and *inner* (*internæ*) those which are situated nearer to the base of the wing and the body. As the outermost feathers are always the easiest to find, we must commence the ordinal numbers (1, 2, 3, &c.) from them.

In *Aptenodytes* (which, at least as regards the plumage is decidedly the lowest of all forms of birds) all the wing-feathers are very small and hard, and have an external resemblance to scales, which are cleft at the margin into a fringe. Like the body-feathers in the same genus, they cover the surface uniformly, without interspaces, like the scales of fishes and reptiles, and form on both sides from 25 to 30 rows, without any difference except that those towards the quill-margin of the wing are somewhat larger, so that they more distinctly cover the roots of the next row.

In all other birds the number of series is much less (at the utmost 12 on each side); they leave considerable interspaces, and are of quite different nature.

As regards the different series, we may accept the following kinds of wing-feathers:—

(1) *Wing-quills* (Pennæ alares, Remiges, Linn. & Ill.) are only a single row, which are seated in the posterior margin of the wing and are the largest of all. All the others are usually named *coverts* (tectrices).

(2) *Large coverts* (Tectrices majores; Pteromata, Ill.), a series of feathers which lie immediately over the roots of the quill-feathers, inserted in the skin behind the muscular layer.

(3) *Second series of coverts*, which are also seated in the fold of skin behind the true arm or hand. They often show the peculiarity that they lie in a reverse position to the preceding, as to which more hereafter.

(4) *Small coverts* (Plumæ or Tectrices minores, brachiales, cubitales, digitales, so-named according to the part upon which they are seated). They form from three to five series, and are placed upon those parts of the skin which enclose the bones and muscles of the limb. They are wanting upon the cubitus in all birds which possess singing-muscles at the lower larynx, but occur in all other birds.

(5) *Arm-fold feathers*, or the anterior small feathers of the wing (Plumæ antecubitales, or Tectrices minimæ), are seated in several rows upon the fold of skin in front of the arm itself.

These different kinds of feathers are :—

Upper (superiores), when seated upon the upper side of the wing, and

Lower (inferiores) upon its lower surface ; and further from the different parts of the arm :—

Upper-arm feathers (humerales) on the humerus,

Forearm feathers or merely *arm-feathers* (cubitales) on the cubitus, and

Hand-feathers, “*Lash-feathers*” (Primores, L.), on the hand.

Upon this terminology we shall have something more to say further on. It is only upon the cubitus that all the different kinds of wing-feathers occur together.

The *structure of the feathers* need not here be described ; it does not belong to our subject, and is treated in detail in Nitzsch's ‘System der Pterylographie.’ Nevertheless a terminology of their external structure may not be superfluous in this place, which will give the opportunity of proposing some small changes in the terms employed by Nitzsch in the above-mentioned work, which he did not himself complete.

The external parts of the feather are as follows :—

1. *Calamus* (the quill-tube, fig. 12, *a*), the transparent, horny part, which is fixed in the skin.

2. *Rhachis* (the shaft, *b*), the part filled with white pith, which bears the vane. On the whole outer side (obverse side) this is clothed with a direct continuation of the calamus in the form of a sharply defined horny lamella. The whole of this side is somewhat convex or flat, without any depression, and scarcely elevated above the vane. The inner or opposite side is considerably elevated above the vane, covered with a peculiar, thinner, and sharply-defined horny lamella, and has a longitudinal impressed line which terminates in the

Umbilicus (*d*), or the opening into the interior of the tube. This opening is very small, and is closed by a projecting point of the dried membranous parts remaining in the tube. Fig. 12 shows a small feather, seen from the reverse side.

Scapus (feather-spool; "stjelk," Markl.) is the name given by Illiger and Nitzsch to the calamus and rhachis together.

3. *Radii* or *R. primarii* (vane-rays), which issue from the rhachis on both sides, close up to and from the horny lamella of the upper surface. Together they form the *vane* (pogonium). They are in general fine, filiform, and nearly cylindrical; but in the large quill-feathers they are flattened, in the form of narrow lamellæ, which, however, are somewhat prismatic, nearly like a knife-blade, so that the thinner, smooth-edged margin is turned towards the reverse side of the feather. The outer margin, which is somewhat thicker, is furnished on both sides, both above and below, with secondary vanes (see No. 4). Nitzsch calls the vane-rays *Rami* (branches), which name is far less suitable than the denomination *radii*, long previously adopted by Illiger.

4. *Radii secundarii* (secondary vane-rays, vane of the second order) issue on both sides from the outer margins of the *Radii primarii*: they issue from the outer side of the vane-rays, just as the latter issue from the outer side of the shaft. These are called *Radii* by Nitzsch; Illiger called them *Radioli* (Terminol. 1269 *h*); the name adopted by me occurs previously in R. Wagner's *Lehrb. der vergl. Anat.* p. 576.

5. *Ciliæ* (Nitzsch) issue in the same way from the *Radii secundarii*, and are extremely fine, hair-like, simple, and short. In the middle of one side of the *radii secundarii* in most feathers they are bent or hooked (*hamatæ*; they are then called *hami* by Nitzsch), in order that they may firmly seize the *radii secundarii* of the next radius. This is the cause of the force with which, in most feathers, the vane hangs together. In those feathers which have not coherent vanes, the *ciliæ* are not hooked.

6. *Plumula accessoria* (accessory plume, *c*)* is a small shaft with its vane, constructed like the larger shaft and vane, which in most small feathers issues from the margin of the

* Nitzsch calls it the *Hyporrhachis* (under-shaft), which name, however, can only be applied to the shaft of the accessory plumule. It might rather be named *Hypoptilium*. The name *plumula accessoria* presupposes that its parts must be called *rhachis*, *pogonium*, &c., *accessoria*.

quill-tube below the umbilicus like a little duplication. It has been regarded as an appendage, or as a small feather growing upon the larger one; but it should rather be regarded from another point of view as being of exactly the same rank as the larger rhachis, although checked in its growth during development. According to this view there issue from each quill-tube two similar vane-bearing rhachides, and in point of fact we find the case to be so in the Cassowaries, in which the accessory plume is as large and of the same structure as the outer shaft and vane. On the body of *Lagopus* the accessory plume is $\frac{3}{4}$, and in *Falco palumbarius* half as long as the outer rhachis, but in both the vane is downy and not coherent. In all these cases we see distinctly that the umbilicus lies between the two rhachides, and that the latter are raised and furrowed on the opposite sides, so that the grooves of both terminate in the umbilicus, and are as it were a remaining trace of it. The obverse side of the accessory plume is thus turned towards the body; it is furnished with a sharply defined continuation of the quill-tube itself, just like the outer rhachis. The vane in both rhachides forms a single uninterrupted series, and in case the accessory plume is wanting, as in the quill-feathers, the vane follows the whole margin round the umbilicus, like a wreath. In the most highly developed feathers, the quill-feathers and the large covert-feathers, the accessory plume is always wanting, and in some birds it is deficient throughout the whole of their plumage. These are, according to Nitzsch—*Strix*, Linn., *Pandion*, *Columba*, and a great many of the Coccoyges, *Pterocles*, *Anas*, Linn., and the Steganopodes. In the Song-birds, and in *Aptenodytes*, the accessory plume is quite small, downy, or rudimentary. The feathers of the last have the true shaft very thick.

SECOND CHAPTER.

Special Description of the different sorts of Wing-feathers.

A. *Quill-feathers* (Pennæ alares sive Remiges).

These, as has already been stated, are distinguished from

all the other feathers by their size and stiffness. They are seated in the skin along the whole posterior margin of the cubitus and hand, but no true quill-feathers occur upon the humerus. They belong definitely to the upper (outer) surface of the wing, for they always lie with their basal ends outside of the bones and muscles. They are always destitute of accessory plumes.

1. *Remiges primores** ("lash-feathers," figs. 3, 4, 7, 8, f), which are seated upon the hand, constitute the most important part of the organ of flight, and exceed all others in size, firmness, the size of the quill-tube, and the shortness and elasticity of the vane. They lie, with the quill-tubes in an oblique direction, strongly attached upon nearly the whole breadth of the wing-bones, and have, in consequence, a very inconsiderable amount of mobility. In number they are usually 10, so that the first is seated upon the outermost (second) finger-joint, attached along its posterior (ulnar) side, less distinctly outwards than the following ones. The second, third, and fourth are placed upon the first finger-joint, and the six following upon the metacarpus (compare fig. 1). The last of them is somewhat longer than the first feather of the arm (*Parus caudatus* constitutes the only exception known to me).

The number of these feathers varies but little; only between 9 and 11. There are 9 of them only in some Song-birds, and this because the first feather disappears (of which more hereafter); and 11 in the genera *Podiceps* (all the Swedish species, also *P. dominicensis* and *philippensis*), *Phænicopterus*, *Anastomus*, *Tantalus*, *Ciconia* (according to Nitzsch also *C. mycteria*, but not *C. argala*), *Musophaga*, and *Corythaix*, but not in *Schizorhis*, Wagl.†

They vary still more in size, proportions, and form, for

* I employ this name, adopted by Linné, in default of a better one, as expressing their position; for the terms *R. manus*, or *digiti*, or *digitales* are not very applicable, and *manuales* is unsuitable. See also the note on the *R. cubitales* further on.

† In the Diving Ducks (*A. glacialis*, &c.) there is a very small third finger-joint, which has a rudimentary first quill-feather, with its small covert-feather. So also in *Uria troile* and *alle*, but not in *U. grylle* or *Alca torda*.

in most of these respects they differ in almost every genus, and often in species of the same genus, especially among the Land-birds. These differences furnish good characters, and belong to the systematic exposition of ornithology; but we may here notice the following more general conditions. The typical form seems to be that all the ten feathers are of equal length; but in consequence of the way in which they are attached to the hand, the first feather projects beyond the following ones, and thus seems to be the longest, while the following ones appear to get gradually shorter. The wing is then quite acute. This form of wing occurs generally among the lower birds, namely in a great many of the Water-birds (all the Pygopodes and Longipennes; the Tubinares, except *Thalassidroma*, *Mergus*, *Fuligula*, and some of the Steganopodes), in more than half the Grallæ (*Charadrii*, *Streptilas*, &c., nearly all Tringariæ [Scolopacinae], though in these often 1=2), but only in a very few others, namely in *Pterocles* alone among the Gallinæ, and in *Trochilus*. In *Cypselus* the second feather is a little longer. In no single true Song-bird is the first feather the longest.

With a higher development of the wing it is instead one of the following feathers (nos. 2-4) that is the longest, while the first is somewhat abbreviated. In those which fly with remarkable rapidity, the second feather is usually the longest (e. g. *Hirundo*, *Ocypterus*, *Falco*, *Merops*); in others the wing is rounded and broad, owing to the third, fourth, or even the fifth or sixth feather being longest; but this last only in short wings. The birds of which the wings are thus rounded and at the same time of considerable length have also very large cubital feathers, and fly remarkably well and steadily (e. g. *Vultur*, *Aquila*, *Ciconia*). Only a few Water-birds have the second feather the longest (*Thalassidroma*, *Anas*, *Bernicla*), and there are not many that possess rounded wings (*Anser*, *Cygnus*, *Carbo*, *Pelecanus*). Among the Waders the two conditions are already more common; rounded wings occur in *Vanellus*, in all Rallidæ (with *Fulica*), in all Ciconiinae, *Grus*, *Otis*, and *Ardea*. In the Land-birds it is the most common condition.

In the Song-birds, without exception, the first feather is abbreviated. In a somewhat higher degree this takes place in two different ways. In a part of them some of the feathers (the anterior) are gradually shortened, by which means the wing becomes short and rounded, and the first feather somewhat shorter than the second (e. g. *Garrulus*, *Regulus*, *Timalia*, *Myiothera*) ; these birds usually fly badly, are seen much upon the ground, and do not fly far. In others the feathers of the first finger-joints (nos. 2-4) are moderately long and exceed the others ; but when this occurs among the Song-birds it is usual for the first feather to be so reduced in size that it either remains as a small rudiment or entirely disappears ; and in this latter case there are only nine primaries (as in fig. 8). This reduction of the first feather is peculiar to the Song-birds, but among them it is quite usual. We may, indeed, estimate that one fourth of the known species are destitute of the first quill-feather, one fourth have it rudimentary, one fourth have short rounded wings with ten primaries, and the remaining fourth have tolerably long wings, but with the first feather shorter than those that follow (e. g. *Corvus*, exotic *Muscicapæ*, &c.). It would appear therefore as if in the Song-birds there was a compensation between the development of the feathers of the first and second joints of the finger, so that the increase of the latter brought with it a diminution of the first feather.

The first feather is deficient especially in many American species ; namely, the American *Sylvia* and their allies, in the *Tanagra*, *Euphonia*, *Hirundo*, and all American Sturninæ and Passeres. In the Old Continent it is deficient in *Anthus*, *Motacilla*, *Hirundo*, and in about one half of the Passeres.

A rudimentary first wing-feather occurs in America almost solely in the *Turdi* ; but in the Old World in the *Turdi* and *Sylvia* and many of their allies, in the *Lani*i (pars), Graculinæ, Cinnyrinæ, Alaudæ, and the Ploceini among the Passeres.

The decrease in size of the outer quill-feathers, or their disappearance, is generally shown more in the fully developed dress and in the males than in the winter garb or

in the females and young. Here belong the so-called subulate, or ensiform, or deeply notched, also, in general, sharp-pointed feathers which only occur among the first of them (nos. 1–3 or 4). In these the vane seems to be obstructed in its growth; but in the females and young such feathers are always broader and less pointed than in the males.

The longest remiges primores occur in some strong-flying genera, which have already been cited, namely, *Sterna*, *Larus*, *Glareola*, *Pterocles*, *Falco*, *Cypselus*, *Trochilus*, *Caprimulgus*, and *Hirundo*, in which, in general, the folded wing is twice as long as the trunk from the breast to the insertion of the tail.

It may be mentioned in this connexion that those birds have moderately long hand-feathers in which the folded wing extends $\frac{1}{5}$ – $\frac{1}{4}$ behind the root of the tail, e. g. *Turdus*.

Rudimentary quill-feathers in the whole wing occur only in two known forms:—*Aptenodytes* (and *Alca impennis*) among the Swimming-birds, and the Struthious birds (with *Apteryx* and ? *Didus*) among the Wading forms; but in none of the higher orders of birds.

2. *Remiges cubitales*, or Pennæ cubitales (arm-feathers)*, are inserted in the fold of skin along the posterior side of the ulna, so that the root-ends always rest against the outer side of that bone. In form they always differ a little from the quill-feathers of the hand, being blunted and more curved, and especially not so thick and stiff, so that they approach more to the form of the ordinary body-feathers; their shorter quill-tubes also are much less firmly fixed, for which reason they possess a somewhat higher degree of mobility. Most of them are nearly of the same size and structure, so that when the wing is folded the inner ones usually extend gradually beyond the outer; but a few of the innermost 2–5 (fig. 3, nos. 14–17, and fig. 8, nos. 8, 9) are always gradually

* They are also called *r. secundariæ*, or *minores*, or *secundi ordinis* (wing-feathers of the second order; “segelpennor,” Markl.); but these names seem to me far less correct than the one above employed, which indicates their position on the cubitus. The denominations *primariæ* and *secundariæ*, or *primi* and *secundi ordinis*, would be much more suitable to designate the different series of wing-feathers.

much diminished in size, and have frequently a different colour and structure from the rest. They are, in this case, softer, more pointed, &c., and both in form and colour resemble the feathers of the back. These have been called *tertiary* wing-feathers, which, however, can hardly be considered right, for they are usually seated upon the cubitus, like the other cubital quill-feathers, from which in a great many birds they can only be distinguished by their diminished size, and they always show a clear transition to them in form and position. Nevertheless the series is continued beyond the joint, so that some of the last are seated upon the humerus in most Raptorial birds, Gallinæ, and Water-birds. They must simply be called *innermost* (internæ) or *divergent* (difformes), because they differ in form and colour from the rest. The latter is, indeed, always the case to some extent with a couple of the innermost quill-feathers; but a considerable difference is observed only in some few genera of diverse orders (*e.g.* in some *Anates*), strikingly in all the Tringaceæ and Charadriaceæ and in *Grus*, less signally in some of the *Rallinæ*, *Fringilla*, and *Emberiza*, Linn.; in a still less degree in the *Sylvia* and many of their allies (but scarcely perceptibly in the *Turdi*), and especially in *Motacilla*, *Anthus*, and *Alauda*, which in this respect, and by many other resemblances, show great analogy with the Tringaceæ.

In number the cubital quill-feathers vary very considerably, namely between 6 (in *Trochilus*) and 36–40 (in *Diomedea exulans*). I append a table [Appendix II.] for the more accurate elucidation of these conditions, showing that the number is in general greatest in Water-birds, some of the Waders (*Ardeæ*, *Ciconiæ*) and Raptorial birds (Vulturinæ); that the average number in the other Raptorial birds, Gallinæ, and Waders is 15–16, which also occurs in many Water-birds; that most of the Coccoyges have 10–13, but that in these, as in all the fore-named orders, the number varies, even in species of the same genus. Only the Song-birds have a nearly constant number—nine, which is the smallest number of general occurrence. Only *Trochilus* and *Cypselus* (among the Coccoyges) have still fewer.

The number of cubital feathers depends upon the length of the cubitus upon which they are inserted; and the length of the cubitus, again, is in proportion to the length of the humerus; we must therefore take these parts into consideration. From what has been said, it is clear that all birds which have many cubital feathers also have long wing-bones and, consequently, long wings. We have just spoken of the wings which are long in consequence of the length of the hand-feathers; these have generally shorter wing-bones.

The length of the wing-bones can only be determined by comparison with the *trunk*; and this must be calculated from the shoulder to the last caudal vertebra (the base or insertion of the tail), to which the rectrices are attached. The shoulder is distinguished by the usually projecting end (or process) of the *os coracoideum* which receives the clavicle (*furcula*), and which may be distinctly recognized under the skin, immediately in front of the humerus. The articulation of the humerus is situated immediately behind this tubercle, in the anterior part of the trunk itself. The first principle of determination is, therefore, to measure how far the posterior wing-fold (the elbow, or the posterior ends of the humerus and cubitus) extends upon the trunk when the wing is folded up. Of all birds, *Diomedea exulans*, which has the greatest number of cubital feathers, has also the longest wing-bones; these reach considerably (by $\frac{1}{13}$ or 32 millim.) beyond the posterior extremity of the trunk. They are shortest in *Trochilus* and *Cypselus*, in which they do not reach quite one fourth of the trunk. In general they are longest in Water-birds, Waders, and Raptorial birds. Thus they reach in *Diomedea* (all species) more or less beyond the base of the tail; in *Pelecanus* and *Fregata* nearly to the extremity of the body ($\frac{7}{8}$?); in *Carbo* rather more than $\frac{1}{2}$ (in *Dysporus* much further).

Among the Gaviæ they reach in *Larus* to about $\frac{4}{5}$; in *Sterna* to $\pm \frac{2}{3}$; in the Procellariæ they vary from $\frac{1}{2}$ (in *Thalassidroma*) to $\frac{2}{3}$.

In *Cygnus* and *Anser* they reach $\frac{3}{5}$; but in the Ducks (*Anas*, *Fuligula*, *Mergus*) only a little more than $\frac{1}{2}$.

So also in the Pygopodes, namely, to $\frac{2}{3}$ in *Colymbus* and *Podiceps*, but little more than $\frac{1}{2}$ in *Alca*, *Uria*, &c.

Among the Waders the wing-bones are longest in the larger *Ardeæ*, in which they are but little shorter than the trunk ($\frac{7}{8}$ or more); in the Ciconiaceæ they reach about $\frac{4}{5}$. (They appear to be longer in *Phœnicopterus*).

In *Grus* and *Otis* they reach to $\frac{2}{3}$; in the Tringaceæ and Charadrinæ to rather more than $\frac{1}{2}$; and in the Rallinæ, with *Fulica*, not quite to $\frac{1}{2}$.

In the Gallinæ the wing-bones usually do not quite reach half the length of the body (in *Lagopus* $\frac{2}{5}$).

The Raptorial birds, again, have them longer, and it is remarkable that those which live upon carrion and fish and about water stand foremost in this respect.

In the Vulturinæ the wing-bones appear generally to reach nearly to the extremity of the trunk; in *Pandion* to $\frac{5}{6}$; in *Aquila albicilla* to $\frac{4}{5}$; in *Aquila chrysaetos* nearly to $\frac{3}{4}$; in *Buteo* to $\frac{2}{3}$; somewhat shorter in *Astur* &c. In the true Falcons they are scarcely over $\frac{1}{2}$.

The Owls are distinguished by their long extremities and larger head contrasted with the small body. The wing-bones most commonly reach to about $\frac{3}{4}$ (*Bubo*, *Aluco liturata*, &c.); but to $\frac{4}{5}$ in *Strix otus*, and only to $\frac{2}{3}$ in *Strix nisoris*, and $\frac{1}{2}$ in *S. passerina* (Day-Owls).

The Cocyges appear to include no form with long wing-bones. Most commonly they reach to about half the length of the body, somewhat more or less (*Columba*, *Cuculi*, *Psittaci*, *Alcedo*, &c.); they are rather longer in *Coracias* and *Caprimulgus*; *Picus* and *Upupa*, which agree so much with the Song-birds, have them rather shorter; *Trochilus* and *Cypselus* have already been mentioned on account of their extremely short wing-bones.

In all the forms hitherto enumerated, the length varies somewhat on either side of the mean numbers here given, even in species of the same natural genus, just like the number of quill-feathers; but this variation almost ceases among the Song-birds, in which the wing-bones generally extend half the length of the body, or are a little shorter (*e. g.* in

Parus and *Passeres*). They seem to be longest in *Corvus*, in which they reach a little over the half of the body, and shortest in *Hirundo* and *Certhia* (and probably in many of the short-winged tropical forms), in which they only reach one third. It must be remarked that precisely those which have the shortest wing-bones are the best and the worst fliers of the whole order.

Two special osteological conditions cause some alterations in the above-cited measurements, although these are rarely of much importance. It must be remarked, however, in the first place, that these, as well as all forms in the skeletal structure of birds, are subject to many exceptions, and by no means indicate the affinities of the species with the same certainty as the external feathery covering. This is therefore noticed rather to give a distinct idea of the constitution and measurements of these parts than to furnish definite characters.

The first relates to the constitution of the shoulder itself. In the Song-birds the *os coracoideum* is, in general, slender, and projects as a short, somewhat inwardly-directed process in front of the articular surface of the humerus. The humerus is attached at the very front of the trunk, and projects nearly as far forward as the true scapular tubercle (of the *os coracoideum*). This bone (humerus) is therefore here but little shorter than the measurement just given, or nearly half the length of the body. In the Water-birds, Waders, Raptorial birds, *Gallinæ*, and in the greater number of the *Coccyges*, on the contrary, the *os coracoideum* is generally thicker, and projects as a very large shoulder-tubercle, like a somewhat longer piece of the same bone, right in front of the articular surface of the humerus. The humerus, therefore, is attached somewhat further behind the shoulder-tubercle, and consequently loses something more of the stated length. Besides this, the great upper edge of the humerus for the attachment of the muscles of the shoulder (representing the *tuberc. majus humeri*) projects, in the Song-birds, directly outwards horizontally from the articular surface, by which means the humerus stands out strongly transversely

at its base, in the form of a tubercle, which, in living or recently shot birds, often seems to conceal the scapular tubercle. Hence if we take the measurement from it we get only the actual length of the *os humeri*, but not the length from the scapular tubercle. The Coccoyges show many considerable differences in this respect, and partly approach the Song-birds, and partly the Gallinæ and Raptores. In the other orders named the same edge is often directed upwards or pressed backwards, as in *Columba*. This, therefore, causes the base of the humerus not to stand out so broadly and not to conceal the true scapular tubercle in fresh birds; but the latter is always perceptible from without, immediately in front of the shoulder-joint.

The length of the cubitus must also be particularly mentioned. The birds which feed their young and possess available posterior toes (*Aves altrices*: "Nesthocker," Oken; Oscines, Coccoyges, Accipitres) have the cubitus longer than the humerus, so that its anterior extremity (with the carpus) stands even with, or somewhat in front of, the shoulder and the breast. In the other birds, however, which have a raised pollex &c. (*Aves præcoces*: "Nestflüchter," Oken; Gallinæ, Grallæ, Anseres), it is in general shorter, even shorter than the humerus itself. This condition, however, is modified in this way: that in all birds which fly strongly, and especially in all which have long hand-feathers, the cubitus is longer, in order to furnish space for the thicker or more numerous *pennæ cubitales*, and through this the carpus projects further in front of the breast. The contrary occurs in the bad fliers.

We see, therefore, in the lowest Water-birds, the Pygopodes, as also in *Mergus*, that the cubitus is much shorter than the humerus, and nearly equally so in the *Fuligulæ*; it is somewhat shorter than the humerus in *Anas* and in *Cygnus gibbus*, equal to it in *Cygnus musicus* and *Anser cinereus*; and somewhat projecting in the smaller species of the genus *Anser*, although the carpus still stands behind the shoulder-tubercle. The same in *Carbo*, *Procellaria*, *Diomedea*. But in *Sterna* and *Larus* the carpus always stands somewhat in front of the shoulder-tubercle.

The Waders are in general good fliers, and in most of them the carpus stands on a level with the shoulder; but in *Ardea*, *Ciconia*, *Grus*, and many which have the longest wings, it stands further forward. In the Rallidæ, on the contrary, the cubitus is shorter than the humerus.

In the Gallinæ the latter condition usually occurs.

In all Raptorial birds the cubitus extends in front of the shoulder, in some nearly one fifth of its own length (e. g. *Pandion*).

The Coccyges vary in this as in many points; but most commonly the carpus projects a little before the shoulder (*Columba*, *Psittacus*, and many others; further forward in *Coracias*; not forward in *Picus*).

In the Oscines this latter condition is by far the most general. I know only a single genus—*Cinclus*—which has so short a cubitus that the carpus does not project before the shoulder. This projection becomes somewhat more considerable in those which fly strongly. *Hirundo*, like *Cypselus*, seems to have received compensation in the cubitus for the shortness of the humerus; for the former is about twice as long as the latter, so that the carpus projects forward about one sixth of the whole length of the body in front of the shoulder.

After this digression from the treatment of the arm-feathers of the wing, we must return to them in order to speak of their size, a point of much importance from a systematic point of view, but hitherto quite neglected. The length of these feathers, as in the case of the wing-bones, can only be measured by comparison with the body itself, namely, by their backward extension when the wing is closed. But as those which are seated upon the posterior part of the cubitus must necessarily project beyond the latter unless they are much shorter than those in front of them, they give no certain measurement, but this must always be taken only from the very foremost feathers, placed nearest to the hand. In most birds the quill-feathers diminish a little, more or less, posteriorly in absolute length, and it is a rare

exception for some of the hinder ones to have a greater absolute length than the anterior (*e.g.* in the Alaudinæ, Tringariæ). It belongs to systematic ornithology to ascertain this. If we wish to have an exact determination of their length, the unequal forward extension of the cubitus just mentioned must be taken into consideration. The best mode of comparison is to state the length of the body, and the distance from the carpus to the tip of the first arm-feather.

The cubital feathers are shortest in the Water-birds and Waders, especially in those which have the first wing-feather the longest. Leaving out of consideration *Aptenodytes* and *Alca impennis*, in which all the quill-feathers are rudimentary, the foremost arm-feathers extend only half the length of the trunk in the Pygopodes generally, although the cubitus terminates anteriorly behind the shoulder. In *Diomedea* they do not reach to $\frac{1}{2}$; in the Anates (with *Anser* and *Cygnus*) to about $\frac{2}{3}$; in *Carbo* to $\frac{4}{5}$; in *Procellaria glacialis* about to $\frac{2}{3}$. In *Sterna*, on the other hand, they reach nearly to the end of the body, and in *Larus* a little beyond it.

In the Waders it is a usual character for the anterior arm-feathers to reach to about $\frac{2}{3}$ – $\frac{3}{4}$ of the body, as in the Tringariæ, Charadrinæ, and Rallinæ. But in the large-winged forms, *Vanellus*, *Ciconia*, *Grus*, they reach about to the root of the tail, and in *Ardea* somewhat beyond it.

The Gallinæ show the peculiarity that the first feather is very short, only $\frac{2}{3}$ – $\frac{3}{4}$ of the following one. The latter reaches to $\frac{2}{3}$ – $\frac{3}{4}$ of the trunk, and this applies also to the male of *Pavo*, which has the last arm-feathers so remarkably elongated. (Of *Argus* I have no sufficiently perfect specimens to examine.)

In all Raptorial birds the first arm-feather extends considerably beyond the root of the tail, except in *Falco*, in which it about reaches to that point. The arm-feathers are longest in the Owls, in which the anterior ones reach nearly twice the length of the body (*e.g.* *Strix lapponica* $1\frac{1}{3}$, *S. liturata* $1\frac{2}{3}$, *S. otus* $1\frac{2}{5}$, *Bubo* $1\frac{2}{3}$). In Eagles and Vultures they are usually about $1\frac{1}{2}$.

In the Coccoyges the first arm-feather is often about even

with the insertion of the tail (*Columba*, *Coracias*, *Caprimulgus*, most *Psittaci*, *Picus viridis*, *Iynx*), rarely a little shorter (*Alcedo*, *Platycercus*, and some other Australian *Psittaci*), but often $\frac{1}{4}$ longer (*Cuculus*, *Pici varii et nigri*); they are much shorter ($\frac{3}{4}$) only in *Trochilus* and *Cypselus*, which, in all respects, have these feathers so peculiarly formed.

In the *Oscines*, as usual, we meet with less variation. In a single form, *Cinclus*, only have I found the anterior arm-feathers not reaching to the root of the tail; they attain only $\frac{3}{4}$ of the trunk. In *Hirundo* and *Sturnus* they extend just to the end of the body, in *Turdus* and *Fringilla* usually a little (about $\frac{1}{8}$ or less) beyond it, in most about $\frac{1}{4}$, and in some (e. g. *Corvi*, *Garruli*, *Pari*) still further (about $\frac{1}{3}$) beyond the end of the body. It would seem as if, in *Paradisea apoda*, they reach nearly $\frac{1}{2}$ beyond the body (*i. e.* to nearly twice the length of the body), but I have only seen stuffed specimens of this genus.

It appears from what has been stated above that the length of these feathers, and consequently the breadth of the wing, varies in a great degree according to the generic form to which they belong, but they also vary a little between nearly allied species. A very slight difference in their length, such as can only be expressed by a small number which might be believed to be of no consequence (*e. g.* $\frac{1}{10}$ of the length, 3–5 millim. in a bird the size of a Sparrow), nevertheless produces a considerable increase or diminution in the whole surface of the parachute formed by all the cubital feathers together, which is not only easily recognized by the eye, but may also have an influence upon the power of flight. But leaving out of consideration the variation in the species, it would seem that these feathers are in general longest in the Song-birds, that they gradually diminish throughout the other Orders, and are smallest in the Water-birds. It ought also to be remarked that the length of the cubital feathers is much less subject to variation in young birds than the hand-feathers, which grow forth later.

We have seen that many weak-flying birds have long arm-

feathers, and consequently broad wings (e. g. *Parus*, *Sylvia*, &c.), that others have them short, and that the same difference occurs in the strong fliers. Thus they show themselves to be the least important part of the organ of flight, but they certainly serve more than the primores to modify the flight. It seems clear, for example, that the birds that fly best, sweeping along with motionless wings, or, as it were, sailing forward through the air, usually in large circles and at an immense height, only possess this power through the great surface which is formed by *long* and numerous arm-feathers, e. g. *Vultur*, *Aquila*, *Milvus*, *Ciconia*, *Grus*. This kind of flight is the most beautiful of all, and ought to be regarded as the most highly developed; for, in the first place, these birds can continue longest in flight, and, in the second, they can always, when necessary, fly just as quickly as the best of other birds, plunge down with the rapidity of an arrow from the most considerable heights, &c. Shorter feathers, and consequently somewhat narrower wings, appear, on the other hand, generally to belong to birds which fly rapidly straight forwards. If these wings are in addition strongly constructed, and long in consequence of the length of the hand-feathers, they give the bird the power of flying strongly, with the faculty of flinging itself about, and turning rapidly within a small space, e. g. *Falco*, *Hirundo*, *Cypselus*, *Columba*, *Cuculus*. This mode of flight is equally of advantage to the Birds of Prey, and to those which have to evade their enemies. The birds which possess short wings always fly with rapid movements of the wings, uninterruptedly when the wing is narrow (e. g. *Pygopodes*, *Anas*, *Gallinæ*), and jerkily when it is broad (e. g. a great part of the *Oscines*, *Picus*, &c.).

We have still a few words to say upon the attachment of the arm-feathers. In all Song-birds they rest with the quill upon the whole breadth of the ulna (see fig. 1, *g*) to which they are firmly and closely attached. In the somewhat more strongly constructed forms the quills are in addition so thick that they leave but little space between them, and pass with their basal ends beyond the ulna a little forward towards the radius; but in all (e. g. even in *Parus*) they are still

large enough nearly to displace the largest covert-feathers, which lie as if firmly grown to the tubes of the quill-feathers. The same thing is met with, more or less, in all birds which have broad wings, and consequently large arm-feathers; but if we compare the Song-birds with other birds which have these feathers equally large*, we shall always find that the former have the feathers resting with a larger part, in proportion to their size, upon the ulna, and consequently also more firmly attached to it, and the covert-feathers more strongly attached to the quills. In the Water-birds, and in general in those which have short quill-feathers, the latter are placed almost behind the wing-bone, and so loosely attached as to possess considerable mobility, and the covert-feathers are inserted separately from the quill-feathers as a distinct series, because the quills are thin and leave considerable interspaces. In this, as in so many other points, *Picus* approaches the Song-birds.

B. The smaller Feathers of the Upper Surface of the Wing.

These feathers are always most developed on the cubitus, where they are also most easily seen and examined; therefore we will start from that part. They have usually all been designated by the common name of coverts. They are of the following kinds:—

1. *Tectrices majores* (great wing-coverts, *Pteromata*, Ill.†, figs. 3, 7, *k*, *l*) form a single series which is always situated immediately within upon the roots of the quill-feathers. They always retain much resemblance in form, texture, and colour to their corresponding quill-feathers, and are always, like the latter, destitute of accessory plumules. They

* E. g. *Corvus*, *Turdus*, *Hirundo*, and *Cinclus*, compared with *Strix* or *Aquila*, *Larus*, *Falco*, and *Anas*.

† The cause of my not setting this name in the first place is that it has never been generally accepted, and that we must not increase the number of terms except when it is clearly unavoidable or decidedly advantageous. The Swedish name “flygpenntäcken,” adopted by Marklin in the translation of Illiger’s ‘Terminologie,’ may be admissible as containing its own explanation.

should be named after their quill-feathers, so that those on the hand are called *Tectrices primores* or *manus* (great hand-coverts), and those on the forearm *cubitales* (great arm-coverts). The former are always inserted in the skin in the same tube with their corresponding quill-feathers, and so close upon the latter that the two seem to have grown together. The same condition occurs with those of the cubitus in all birds which have large cubital feathers, as already stated.

The greater hand-coverts (*T. majores primores*) are equal in number to the quill-feathers. The outer ones always diminish in length more than the quill-feathers, so that the first and second are shorter than the following ones, when, for example, only the first quill-feather is somewhat shortened. They are most frequently whole-coloured and dark, very seldom spotted.

Of the *tectrices cubitales* there are always one or two more than of the corresponding remiges; thus, externally, there is always one small supernumerary one (*l*, no. 1). Properly, they ought to be of equal number, as the feathers here, as everywhere, are arranged in quincunx (rows of three different sets), which constitutes a continuation of their arrangement on the hand. The supernumerary coverts seem to me therefore to show that a quill-feather, which ought to have been placed in the middle of the wing-fold, is not developed. These coverts appear in general to increase in length inwards, as the inner ones cover a greater portion of their corresponding remiges than the outer ones; but this is usually due to the fact that the remiges decrease inwardly somewhat in length, while the coverts do not diminish. In the Song-birds they are so short that they do not attain half the length of the remiges, except inwardly in some genera; but in all other orders they are larger, so that they always reach beyond the half of their corresponding remiges, even the outermost (see figs. 7 and 10, *l*, of Song-birds, and figs. 3 and 11, *l*, of another order). Only some Pici (*varii*) and *Upupa* constitute an exception to this, for in this respect they present the same conditions as the Song-birds.

This is due not only to the greater length of the remiges in the Song-birds, but really also to the greater length of the coverts in proportion to the body in the other orders, which distinctly shows that in the Raptorial birds, *Ardeæ*, *Ciconiæ*, and all other birds of which the cubital remiges are comparatively of the same length as those of the Song-birds, the coverts reach beyond their middle. *Cinclus*, which has shorter cubital remiges than other Song-birds, nevertheless retains the proportions of that order, and a direct comparison between nearly equally large, and in other respects similar, species shows it distinctly, e. g. *Hirundo*, *Turdus*, *Corvus*, compared with *Cypselus*, *Cuculus*, *Coracias* (see fig. 10, *Turdus*, fig. 11, *Cuculus*). In some Water-birds and small Waders the great cubital coverts are but little shorter than the remiges; in other respects they present many peculiarities, e. g. in *Gallus*!

If this difference in the size of the coverts be taken together with the difference which will be mentioned below (under § 3), it is the most easily recognizable and most general of all the external characters at present known by which the Song-birds are differentiated from the other orders.

2. *Tectrices secundæ seriei* (the coverts of the second row, *m*, *n*), which lie immediately upon the greater coverts, generally resemble the ordinary feathers of the body. Those which belong to the cubitus have usually the peculiarity of lying reversed with relation to the greater coverts and the remiges, so that the inner margin of each feather (that turned towards the humerus) is free and covers the outer margin of the next one. But I have always found them unreversed in *Trochilus*, *Coracias*, *Cuculus*, *Columba*, *Gallus*, *Lestris*, *Larus*, *Sterna*, and *Uria*, as well as in young Song-birds in their first dress*. They are inserted in the skin either immediately behind the muscular layer,

* Mr. W. v. Wright has kindly communicated to me the observation made by him, that some of those which lie far back on the cubitus, together with the corresponding feathers of the next series (§ 3), resume the right position (like the remiges) in all Gallinæ and Water-birds (see fig. 3, *n*, *n*).

between the roots of the remiges and greater covert-feathers, or within the muscular layer, close upon its hinder limit. (The latter in the Oscines, e. g. *Parus*.) They are most visible in the Oscines, in consequence of the absence of the next series, and are quite short, soft, and usually distinguished by a peculiar colour-marking, e. g. white at the apex in many, so that they form a transverse band upon the wing. (A transverse band upon the wing is almost still more frequently produced by the apices of the greater covert-feathers, which, in the Song-birds, are often white, yellow, or of paler colour).

These feathers seem to have been but little observed. According to the definition in Illiger's 'Terminologie,' they constitute his "*ptila*," which are said to lie immediately within the pteromata; but the want of any special name for all the following smaller feathers seems to show that Illiger included them also under the name of *ptila*. In the Song-birds, in which they alone are *reversed*, they may receive this name (*perversæ*); but it seems to me to be safest to employ the denomination above given, which at any rate is correct. If we had not accustomed ourselves to an entirely different signification of the names *primariæ* and *secundariæ*, these terms would undoubtedly have been best of all adapted for these two series, the first and second coverts.

3. The *Tectrices minores cubiti vel manus* (smaller wing-coverts, figs. 2, 3 *b*) form several (2-5) series inserted in the skin upon the bones and muscles of the arm or hand itself. In form they do not differ at all, or but slightly, from the feathers of the body, and in position they agree with the next preceding series, inasmuch as their margins cover each other in a contrary way to those of the remiges. But they lie similarly reversed also in those birds in which those of the second series are not reversed (*Coracias*, *Cuculus*, &c.).

In the Song-birds these feathers should properly form three series on the cubitus, but they show the remarkable peculiarity that they are never fully developed. Only in the young in their first plumage, and in the winter plumage, a few of them, but never all, occur in the form of down, or of

very small undeveloped feather-rudiments, covered up by the next following perfect feathers. In older birds in the summer plumage scarcely a trace of them is usually visible.

This remarkable structure is so peculiar to those birds which have the inferior larynx furnished with five pairs of muscles, that I have been unable to find any other form except *Cypselus* which resembles them in this respect; but it occurs in the whole of them without a known exception, and consequently forms a certain external character for them*. In every Song-bird, even when sitting with folded wings, and in stuffed specimens, we recognize this deficiency at the first glance; it causes the wing to exhibit only a small number of coverts, and these to occupy an inconsiderable space in comparison with those in the wings of species belonging to other orders (see figs. 10, 11).

All other birds have these feathers developed. In *Picus* and *Upupa*, which of all those which have no song-muscles most resemble the type of the Song-birds and seem to constitute the real transition to them, the second and third series are fully developed, but the first is incomplete, so that it merely consists of a few feathers towards the carpus, and all are so short that they project but little over the next following ones, and therefore may easily be overlooked in dried specimens. Except these I know no form in which they are less distinct or perfect. Three series occur in the Psittaci, all Raptorial birds, most of the smaller Waders, and in *Anas*; four in *Coracias*, *Cuculus*, *Gallinula*, *Limosa*, *Lestris*, and *Fuligula*; five in *Columba*, *Tetrao*, *Numenius*, *Podiceps*, *Colymbus*, and *Larus*, as also in *Carbo*, which has them dark-bordered. A more special study of them will no doubt repay

* I have recently had the opportunity of examining a softened skin of *Menura lyra*, and convinced myself that this bird also agrees perfectly with the Song-birds in this respect; it ceases therefore to be a probable exception, just like the other two, *Picus* and *Upupa*, which I previously regarded as such. On the other hand, I afterwards found that *Cypselus* has these feathers exactly as in the Song-birds, which was previously accidentally overlooked, probably on account of the size of the covert-feathers which occur.

the trouble it causes, but I have omitted it; it can be undertaken only with freshly killed birds.

On the hand these feathers are continued in two or three series, which in no respect differ in structure from the second series of coverts, and exactly cover the small portion of the hand which is not clothed by the large coverts. They are usually concealed by the quill-feathers of the thumb, and always lie right, *i. e.* not reversed as on the cubitus.

4. The *Tectrices minimæ s. antecubitales* (smallest or foremost covert-feathers, figs. 3 and 7, *e*) are seated in several series upon the fold of skin in front of the cubitus. They are right-lying, not reversed like those on the cubitus itself. But we often find one of these series reversed, in agreement with the preceding ones, *e. g.* in the Gallinæ, in the diurnal and nocturnal Birds of Prey, and many others. The series of feathers which are counted parallel with the preceding run obliquely towards the anterior margin of the fold of skin (see figs. 2, 3, 6, and 7); but in some Waders, in *Larus*, and especially in the lower Water-birds (Pygopodes, Procellarinæ), the fold of skin is very narrow in front of the cubitus, and covered only by 2(-3) complete rows of small feathers. In certain Psittaci and some few other birds, the feathers which are placed nearest to the margin have peculiar luminous colours. This margin was called the *campterium* by Illiger. I am inclined to think that we should do better by calling it simply the *margo alæ cubitalis, carpi*, &c., according to circumstances.

C. Lower Wing-feathers.

1. *Tectrices aversæ s. inferiores primæ* (reversed feathers, figs. 4 and 8, *o, p*). These are situated closest to the roots of the remiges, behind the muscular layer of the wing. They have undoubtedly the most singular position of all the feathers on the bird's body, for although they belong to the underside of the wing, their position is the same as that of the remiges, so that when the wing is considered from the underside they show their reversed side (with a raised, grooved shaft, &c. *Vide antea*, p. 397, 2). The right side is turned in-

wards, towards the remiges. The inner branch, which in all other feathers is an accessory plume, seems therefore in these to have been fully developed, while the outer branch quite disappears, for it is entirely deficient, and has not even persisted in the form of an accessory plume. These feathers constitute two series (one of which, however, often disappears), which may be regarded as corresponding to the first and second series of covert-feathers (or possibly the quill-feathers and greater covert-feathers of the upper surface!). They often retain a rigidity and straightness and an external form which give them some resemblance to quill-feathers.

On the cubitus the feathers of the first of these two series are firmly attached, and just like the remiges, with the inner (posterior) margin free, covering the outer (anterior) margin of the next feather; but in the second series they are movable and, more than any other wing-feathers, can be suppressed; further, they lie with the margins in the opposite direction to the former, so that the outer edge of each feather is free and covers the inner edge of the next one. This is so constant that I have never found an exception to it; and when either of the two series is entirely deficient, we can recognize by the position of the margins which it is that remains. The two series are continued upon the hand, but here they are often interrupted or divergent. In those birds in which the cubital remiges are continued beyond the joint upon the humerus (Gallinæ, Raptorial birds, Waders, Water-birds), the second series of reversed feathers is continued in the same way, but not the first (see fig. 4, *o*, nos. 1 & 2).

In all Song-birds the whole of the first series is so completely deficient that not a trace of it remains. The second series consists usually of small feathers with downy edges, which are concealed by the following ones; but in *Corvus*, *Garrulus*, *Troglodytes*, and *Cinclus* they are larger and firmer; in *Ampelis garrulus* and in some Passeres (e. g. *Pyrrhula*) they are concealed everywhere except upon the middle part of the hand, where they project beyond the following feathers.

In all the other orders, on the contrary, the first row appears always to occur; and if either of them is wanting or

rudimentary, it is the second. *Picus* alone agrees with the Song-birds. *Cypselus* and *Trochilus* have the first series perfectly developed, but seem to want the second entirely. In *Psittacus ochrocephalus*, Wagl., which likewise has the first series large, the second also occurs, but quite rudimentary and concealed by the following feathers. The same condition appears to me to occur in *Coracias* and *Cuculus*. *Columba*, on the other hand, has the first series small, concealed by the second, but, upon the hand, first interrupted, then again continued and larger; the feathers of the second series are very large upon the cubitus, but soon cease upon the hand, upon which they seem to form a single row with the first.

In the *Accipitres diurni* and the *Gallinæ* (fig. 4, o, nos. 1, 2) the first series is pretty large and the second quite small, and concealed by the following feathers, or quite rudimentary. In *Falco subbuteo* they seemed to me to be entirely wanting; and the first series was concealed by the third. The Owls, on the contrary, have both series large; but in *Strix nisorica* the first is concealed by the second and downy at the edges; in *Strix aluco* the first series is the largest.

Among the *Grallæ*, these series in the *Rallidæ* seem to resemble those of the *Gallinæ* and *Raptores*. In the *Tringariæ* (*Scolopax*, *Numenius*) the first is the largest and continued upon the hand; the second soon ceases upon the hand, and becomes so high posteriorly upon the cubitus as to conceal the last feathers of the first series. *Grus* and *Ciconia* have the first series unusually large, especially inwards; and the second of moderate size.

In the Water-birds (*Anas*, the *Pygopodes*, and *Sterna*) those of the first series are very large; they reach to about $\frac{3}{4}$ of the remiges, and are continued to the end of the wing; the second are smaller, and cease a little before the tip of the finger. In *Carbo* the second series is small and concealed. In *Larus* both are very large and nearly similar, so that the first series is evenly concealed by the second, except posteriorly, where it projects far out. In *Uria grylle* the first series is large, the second small and concealed, but quite right-lying, with the obverse side turned away from the surface

of the wing. In all non-Song-birds which have the feathers of this series small, there seems to be a distinct tendency, under certain circumstances, to turn them *right*.

2. The *tectrices infrabrachiales* s. *plumæ infracubitales* &c. (inferior arm-feathers, figs. 4 and 8, *q*) are seated upon the lower surface of the arm itself, the hand, &c., and turn their reverse side towards the part upon which they are inserted, as feathers usually do. But the edges of those on the cubitus have a reversed position, so that, although belonging to the underside of the wing, they lie like the margins of the remiges. This is particularly remarkable, as such a reversed position as compared with the other feathers also occurs in those which clothe the outer surface of the cubitus.

These feathers appear to me to show several differences from the others in number, size, position, &c., of which the following few remarks are only to be regarded as examples. In order to define their position more accurately, we may, if necessary, distinguish between *radiales*, *ulnares*, and *post-ulnares*, according as they are placed upon one or other of the wing-bones or quite posteriorly, with the preceding, behind the great sinew of the cubitus (*fascia tendinea*; see further on), which last is the most usual of all, for the first series there situated occurs in all birds and is often alone. It is to be remarked that we are speaking here only of series which consist of true feathers, of which there are but few, usually only 1-3; but in most birds, except the Song-birds, there is an abundance of down.

The birds provided with a singing-apparatus have in general only a single series of inferior cubital feathers, which are inserted behind the *fascia ulnaris*, are long and soft, and cover the preceding feathers (fig. 8, *q*). In *Corvus*, however, there is also a small series close behind the first.

In *Picus* and *Cypselus* also the first series alone is developed, but not so long; the second series is rudimentary. *Columba* has a moderate-sized and a small series upon the ulnar surface; then down; and then two small, nearly rudimentary, radial series. In *Psittacus amazonicus* there are two tolerably large postulnar series; then three small series

in front of the *fascia tendinea* of the arm. (In *Psittacus magnus*, Linn., the first of these is seated upon the fascia itself.)

The Raptorial birds have most frequently three series seated upon the underside: the first consists of large, and the last of very small or quite rudimentary feathers. In *Strix liturata* and *Falco subbuteo*, however, I found only one large, and one nearly rudimentary series.

Among the Gallinæ the species of *Tetrao* have three definitely developed ulnar series (fig. 4, *q*, 1, 2, 3), and two or three nearly downy, small radial series.

Fulica has only the three rows on the ulnar surface formed as in *Tetrao*; *Ciconia nigra* scarcely more than two. *Numenius* and *Scolopax* have on the ulnar surface one moderate and one very small series; and on the radial surface one small and one rudimentary series.

In the *Fuligulæ* (*spectabilis*, *glacialis*) there are three series behind the fascia, namely one of middle size close upon the reversed feathers, and after this two series of very small feathers, which are placed alternately, but so close together that they seem almost like a single one; and, finally, three distinct radial series in front of the fascia. *Sterna hirundo* has only the three first-mentioned. *Podiceps* possesses only one series behind and one before the fascia; *Uria grylle*, on the contrary, has a pretty large one behind and three small ones in front of the fascia.

On the lower surface of the hand itself there are from three to four irregular series of short, rounded, and adpressed feathers, which closely cover this part, as on the outer surface (figs. 4 and 8, *r*).

3. The *tectrices antecubitales inferiores* or *inframarginales*, the lower marginal feathers of the wing (*s*), clothe the underside of the great fold of skin between the humerus and cubitus. In general they only form two or three series, situated beneath the margin itself, so that the greater part of the fold of skin is destitute of feathers, or has nothing but down. In all birds they are in all respects right-lying or opposite to the remiges. Thus they show the right side, and

cover the next feather with the outer margin. In front of the humerus they sometimes take on another form.

In the Song-birds there are only two series immediately beneath the margin of the skin, and these are continued without any alteration as far as the base of the humerus. They are unusually soft, with separate hair-like rays, so that they do not present a definite outline (contour). Those in the outer series are small; but those of the inner one are very long and curved, and cover the whole under surface of the arm. In *Corvus* and *Cinclus*, however, they are flat and have a more definite form.

Among the Coccoyges, *Picus major* and *P. martius* have these feathers nearly as in the Song-birds, but not so long, and of a more definite form; *Picus viridis*, like the Psittaci, has three series, none of which has very long feathers. *Columba* proves to be distinctly divergent; the fold of skin is clothed with three more widely separated series, of which only one occupies the margin, the second the middle, and the third the inner part of the fold, without any downy series. These feathers are rather short, rounded, and not curved.

Strix has two series, of which the inner one consists of feathers of moderate length, soft, and but little curved; near the body they are larger. In *Aquila*, *Buteo*, *Pernis*, *Astur*, and *Falco* there are from four to six series below the margin, which occupy a considerable portion of the breadth of the fold, but nevertheless leave room for downy series close to the cubitus. The innermost are of moderate length, the others short; all are firm, of definite form, and but little curved.

In *Tetrao* these feathers perfectly resemble those of the diurnal Birds of Prey.

Fulica has three series, of which the inner are long and exceedingly soft. In *Numenius*, *Scolopax*, and *Ciconia* there are also three series, but tolerably firm and of definite form—the inner of moderate size, the two outer very small.

In *Anas*, Linn., there are only two series of short, ovate, scarcely curved feathers, immediately under the

margin ; towards the body they become longer ; so also in *Podiceps*, *Colymbus*, *Alca*, and *Uria*. In *Lestris* a third very small series is added on the margin. *Larus* has a moderate uniform series and a small one.

D. *The Rest of the Wing-feathers,*
on the pollex and humerus (and the wing-spur).

1. *Plumæ pollicis*, *alula* s. *ala spuria* (thumb-feathers, *d*), seated upon the pollex. These are usually from two to four rather large feathers, which have the aspect and firmness of true quill-feathers, and reach somewhat beyond the end of the small covert-feathers of the hand. Properly, there would seem to be always four of them, but the two lower ones, or only one, are often soft and exactly resemble the small covert-feathers of the hand.

In the Song-birds we can generally count only two thumb-feathers, or three when one of the coverts acquires a somewhat more definite form. So also in *Picus*. They are more definitely three in the other Coccozyges, Tringaceæ, and *Anser* ; and four in the diurnal Raptores, the Gallinæ, the other Waders, and the Water-birds, in which all the feathers of the thumb acquire the quill form.

In the Song-birds the thumb is free for half its length or nearly to its base ; but in the Water-birds (*Anas*, the Pygopodes, *Larus*, and *Carbo*) it is loosely attached to the hand by skin up to the tip, and in *Aptenodytes* no trace of it is visible externally. Among the Waders it is completely united in *Ciconia*, but has the tip free in the Tringariæ. The Gallinæ, Raptores, and Psittaci have it nearly half-free. In *Cypselus* it seemed to be completely united.

Upon the names of *alula* and *ala spuria* it is to be remarked that I can see no particular advantage in employing them in preference to the much more natural one, *plumæ pollicis* ; and, further, that they have been very much misapplied both in older and newer descriptions of birds—*e.g.* in Wagler's writings, in which they most frequently indicate the great covert-feathers of the hand.

At the tip of the thumb there is a small *claw* or *nail* in

many forms of birds, possibly in all except the Song-birds, Pici, and Owls. It is very long, strong, and hooked in *Struthio*; long, straight, and pointed in *Ciconia* and *Sterna* cylindrical, blunt, and but little curved in *Cypselus*; similar, but small, in *Falco palumbarius*; very small, flat, nearly of the form of the human nails, in *Columba*, the Gallinæ, Anates, &c. In *Struthio* (*S. camelus* and *casuarius*) there is also a claw at the apex of the large finger of the wing.

2. *Pennæ humerales* (quill-feathers of the humerus, figs. 2, 3, 6, & 7, *t*).—We may so name, although not quite properly, from three to six small, nearly always concealed feathers which spring from the upper surface of the humerus close to its apex. They are distinguished, when they are developed, by some resemblance in form to the *remiges cubitales*, and have most frequently a different colour from the dorsal and covert-feathers; but if we trace out the series which they form, they are found to constitute a continuation of the *teatrices minores cubitales*. The middle one or more are always the largest.

In the Song-birds they are very small, soft, and downy at the margins, and therefore difficult to distinguish. However, they may be distinctly recognized in *Fringilla* and *Pyrrhula*.

Picus has 3, very small but distinct; *Psittacus* has 4, and *Coracias* 5, well developed; but in *Columba* and *Cypselus* they can hardly be distinguished. In the Accipitres there are always three or four distinct ones, but very small, and differing considerably in form. So also in the Gallinæ.

In *Scolopax*, *Numenius*, *Totanus*, and many of the smaller Waders, I have counted 5 very distinctly: so also in *Fuligula*; 6 in *Cygnus*, *Lestris*, and *Colymbus*, and 8 in *Podiceps rubricollis*. *Larus* has two pretty long ones and some very small.

This series of feathers is followed, in front, by one or more series which can only be called *teatrices humerales*. They have quite the aspect of covert- or dorsal feathers.

Nitzsch names these feathers the *parapterum*, which name is, however, employed by Illiger in common for these and

the *infrahumerales* and *scapulares*. It seems to me that this term may and must justly be dropped.

3. *Plumæ infrahumerales* (the inferior feathers of the humerus) on the underside, opposite to the preceding.—Some of them, situated on the anterior surface of the humerus (fig. 5, *u*, fig. 4, *n*), are very strongly developed in the Waterbirds and Waders, most frequently very long, slender, straight, and somewhat obtuse. The middlemost are always longest. There are from 7 to 9 of them. It is quite the same in the Gallinæ and diurnal Birds of Prey, but the number is only 7 or 6. In the Owls they are small and less distinct. *Columba* has 5 flat and tolerably large ones. In *Coracias* they are very large; in *Cuculus* distinct, but not large. Most of the Psittaci have them very small and indistinct, but *Psittacus amazonicus* has 2 very long ones.

In *Picus* and in all the Oscines this series of feathers, which in all those previously mentioned are large, is wanting, and in them there is merely a row of small feathers upon the posterior side of the arm (fig. 9, *u*), and these also occur in the preceding below the humerus.

These series of feathers seem to form continuations of the *tetrices infracubitales*. Of all birds the Tringariæ (*Numenius* &c.) have them most developed; in these the series is continued by 3–6 feathers, which seem to be seated upon the hypochondrium itself.

The name *hypopterum* adopted by Nitzsch is, in my opinion, for reasons already given, to be mentioned here only as a superfluous synonym.

4. In immediate sequence to the two kinds of feathers last discussed, another sort must be mentioned in a few words, as, although they do not belong to the wing, they stand in close connexion with it, namely:—

The *plumæ scapulares* (shoulder-feathers, figs. 2, 3, 6, 7, *h*), which form a usually multiple series upon the body across the upper extremity of the humerus, therefore immediately above the scapula and parallel to it. They constitute Nitzsch's *pteryla scapularis* (figs. 2, 6, *h*). No doubt the name *parapteron* was originally formed for these feathers;

subsequently they have been called *pallium* &c. They are very different in number and size, for which reason they often furnish good generic and family characters. As an example we need only cite the division of the genera of Alcedines, which I have already made in the Vet.-Acad. Handl. 1835. Those which live on the Old Continent (*Halcyon*, *Alcedo*, &c.) have such large scapular feathers that they quite cover the usually shining blue hinder part of the back. The genus *Ceryle*, Boie, which includes the American species, and *Alcedo rudis* on the Old Continent, is chiefly distinguished by its short scapular feathers, which, as in the Song-birds in general, do not seem to be differentiated from the dorsal feathers, although they form, apparently always, a series widely separated from the latter.

THIRD CHAPTER.

On the Muscles and Dermal Surface of the Arm.

If the feathers be removed from the cubitus of a Song-bird, we find on its under surface a very deep and narrow pit of half the length of the cubitus (which we may call the *sinus cutaneus postularis*, fig. 9, *b q*), produced by the skin being folded in between the ulna (*b*) and the sinew of the *musc. flexor carpi radialis* (*q q*), which latter lies transversely upon the underside of all the remiges of the arm, and also externally in front of the true arm. Near this we see another, shallower, but generally somewhat broader pit (*bs*), between the ulna and the radius, and in both are situated some down or rudimentary feathers. These pits are deficient in all Water-birds and Waders, in which the arm at this point is flat and even. In many forms of these two orders (e. g. *Carbo*, *Sterna*, *Ciconia*) there is an inconsiderable impression in place of the pit between the radius and ulna, but of the true sinus no trace occurs. The Gallinæ, diurnal Raptores, *Psittacus*, and *Columba* show the same characters. The nocturnal Raptores (e. g. *Strix liturata* and *S. lapponica*) have the pit between the radius and ulna very large and deep, but no sign of the sinus behind the ulna. In *Cypselus* there

is only an inconsiderable shallow depression in the place of this latter, and that between the two wing-bones is broad but not deep. In *Picus* the two pits are formed as in the Song-birds, but somewhat shorter. *Hirundo* has them both longest and deepest of all birds known to me.

As this difference in the exterior is manifestly founded upon a different arrangement of the parts situated under the skin, it seemed natural to make a new investigation of the muscles; and although this has not been successful in furnishing the grounds of an explanation of the differences in the wing-feathers of the Song-birds and the other orders, what has been ascertained may nevertheless be briefly recorded.

The muscles of the wing have already been described by several authors, but best, and with a comparison of all orders, by Schöppss in Meckel's 'Archiv,' 1829. This remarkable memoir ascribes to the whole wing forty-eight muscles, of which I propose to mention only a small part, namely, the muscles of the cubitus, and, supplementarily, those of the humerus. I pass over the muscles of the hand, as also those of the shoulder; and with regard to the latter I will merely remind the reader of the corrections recently made by Retzius (Skand. Naturf. Sällsk. Förhandl. 1842) upon the older descriptions of them.

Under the skin the whole of the forearm is, as usual, clothed with a thin aponeurosis (*fascia cubiti*), which gives off sheaths between the muscles, sinew-sheaths, &c. In birds it also forms a peculiar independent band (*fascia ulnaris*), which commences right upon the convexity of the *humeri condylus internus*, and finishes with one end upon the *os pisiforme*, and with the other in the *ligamentum carpi*. This band therefore lies along the ulna, but separated from it by a considerable space, which is occupied by the flexor muscles. Only in the lowest Water-birds (*Pygopodes*) it lies close upon the ulna, united to the bone like a direct continuation of the periosteum. It always passes straight forward, strongly strained between its points of attachment. This band plays a principal part in our exposition, and I

must therefore commence with its description, for where it is strongly developed, flat, and broad, it fills the whole space between the sinews, which, in the Song-birds, is occupied by the above-mentioned *sinus cutaneus ulnaris*, in consequence of which this entirely disappears.

The muscles are as follows :—

A. On the outer (extensor) side of the cubitus, springing from the *humeri condylus externus* and the radius. They are in general extensors, and form together in Birds a large mass of flesh.

a. Long muscles (for the hand).

1. *Extensor carpi radialis longus* *, usually the largest on the forearm ; lies usually foremost on the radius ; springs from the humerus above the *condylus externus* ; the sinew terminates at the *tuber baseos metacarpi* quite in the margin of the wing, below the thumb. It is the principal extensor muscle of the hand and the largest remiges.

2. *Extensor carpi radialis brevis*, concealed between the radius and No. 4 ; springs from the posterior (ulnar) side of the radius ; is often very small, always much narrowed to a point, with a slender sinew, which comes from near the end of the radius, and is attached beneath the preceding muscle.

3. *Extensor digitorum communis*, from the *condylus externus* close upon the radius, visible externally beside No. 1. —Sinew long, runs to and along the front margin of the *os metacarpi* to the base of the first phalange, forming there a sort of trochlea ; thus it goes from the outer side across the fore margin of the bone to the inner side, where it is attached to the *tuberculum marginis antici*. The sinew gives off a strong branch, like a filiform ligament, to the base of the thumb, as it passes by the latter. It extends

* The names here given are those employed in human anatomy, in order to show the analogy more distinctly. As, however, the same part often performs different functions in different animals, the names derived from the functions are often unsuitable, e. g. No. 5, which in birds is not an extensor. So also with *supinator*, *pronator*, &c.

the finger and turns it a little so that the tips of the largest feathers are turned downwards; it likewise flexes the thumb. (The course of the sinew is analogous to that of the *Fl. dig. prof.* No. 11.)

4. *Extensor indicis proprius* (essentially an *extensor profundus*, answering to the *flexor profundus*), beneath the preceding, nearly between the radius and ulna, attached to the radius.—The sinew runs to the anterior margin of the metacarpus through the same sheath as the preceding, passes over the bend of the latter, and is attached at the base of the second phalange on the outer side, near the *flexor profundus*.

5. *Extensor carpi ulnaris*, visible externally near No. 3, is always firmly united with the ulna by cellular tissue, behind No. 6, and usually commences in common with the latter from the *condylus externus*, or on the surface of its basal sinew.—The sinew passes backward over the apex of the ulna, and attaches itself at the base of the *os metacarpi* on the outer side. (Called by Schöpss, “*abductor metacarpi*.”)

b. Short muscles (attached to the radius or ulna).

6. *Humero-ulnaris externus*, commences in a point, with a short, strong sinew, upon the *condylus externus*; it is large, but quite covered by the preceding; it is broadly attached and generally spread out upon the anterior surface of the ulna (near the *ligamentum interosseum*). It seems to serve both as a flexor and to give firmness to the joint. (Called *flexor profundus antibrachii* by Schöpss; see further on under No. 15.) Leaving out of consideration some difference in position, it might be regarded as the same as the *anconæus parvus* in man. Except this, there is nothing with which it can be compared. I have, however, adopted a new name for it; for the reason of this see further on.

7. *Supinator radialis* is only *one* in birds, concealed under No. 1, in front of the radius; it springs from the *condylus externus*, united with No. 3, but beneath it; and is attached to the middle of the anterior surface of the radius without a

sinew. It seems reduced merely to act upon the capsule of the joint; supination is impossible. Its development seems to proceed *pari passu* with that of the *pronator superior* (No. 13); they generally terminate close together upon the radius.

B. On the inner (flexor) side of the cubitus, springing from the *humeri condylus internus* and the *ulna*. These are flexors in their nature.

The muscles of the forearm seen from this side form three great masses or groups, the sinews of which are separated by the above-mentioned pits when the latter are present. The anterior mass consists of the preceding Nos. 1 and 7, the posterior of Nos. 8–10, and 15, the middle one at the upper part of the *pronatores*, and then of Nos. 11 and 12.

a. Long muscles for the hand.

8. *Flexor carpi ulnaris*, from the *condylus internus* to the *os pisiforme*, below the *fascia ulnaris* or behind (beyond) it; first beside the ulna, then behind it, as if outside the arm. It is usually one of the largest cubital muscles, very fleshy with a strong sinew, the principal flexor muscle of the hand.

9. *Rector remigum cubiti*, constitutes as it were a part of the preceding, forming its hinder edge from the *condylus internus*; it gives off small sinews to all the remiges, and finally one to the *ligamentum carpi*. It therefore corresponds to the *palmaris longus* in man.

10. *Flexor digiti sublimis*, a long, slender, generally very small muscle, attached beneath the *fascia ulnaris* and quite concealed by it. It lies either on the surface of No. 8, or close to it on the radial side. The sinew is usually fine, passes round the radial side of the *os pisiforme*, obliquely over the metacarpus to the radial side of its apex, and attaches itself at the base of the first phalange, quite at the radial margin of its articulating surface; it seems therefore to act only as an extensor. (The sinew may be traced to the base of the second phalange in *Strix nisor*, *Anas glacialis*, and, according to Schöppss, in *Psittacus*, *Fulica*, and *Aptenodytes*, but not in *Falco palumbarius*, &c.)

11. *Flexor digiti profundus*, attached to the ulna under No. 8 (*fl. carpi uln.*).—Sinew thick, passing under the *ligamentum carpi proprium* to the radial edge of the metacarpus, through the same sheath as the sinew of the preceding, but outside of it, continued along the inner side of the radial edge to the articulation of the second phalange, where it passes transversely across the margin of the bone inwards to the middle of the front margin of the articular surface. In *Cypselus*, *Falco*, &c. it is attached here; but in *Anas* it passes at this point into a longitudinal groove in the radial margin of the second phalange (which forms at the base a complete aperture), and is attached in the middle of the radial margin of the second phalange. The sinew passes by that of the *flexor sublimis*, but does not pierce it as in the Mammalia. It appears to flex the finger, and especially the second joint, in opposition to No. 3.

12. *Flexor carpi radialis* lies under the preceding, attached to the ulna, and not so high up as in man; passes obliquely forward to the *os carpi anticum*, under the sinews of the two *flexores digitorum* (10, 11), curves forward around the above-mentioned bone in its groove, and attaches itself at the outer side of the *basis metacarpi*.—Flexes the hand and turns it outwards.

b. Short muscles (as on the outer side).

13. *Pronator superior*, from the upper anterior side of the *condylus internus* to the middle part of the radius; inserted upon the anterior part of the inside of the latter; usually very strong. Appears to act, in birds, like Nos. 6, 7, and the following one, partly as a flexor, partly to hold together and strengthen the joint, for pronation is impossible.—This and the next together represent the *pronator teres* in man. Schöppss calls this (No. 13) *brevis*, and the next (14) *longus*, which, when applied to most birds, is reversed or incorrect; the names must therefore be changed.

14. *Pronator inferior* (s. *profundus*), lies generally under the preceding, between the *condylus internus* and the radius,

on the *ligamentum interosseum*; but in *Picus* and *Pernis* it is also inserted upon the ulna.

15. *Humero-ulnaris internus*, from the *condylus internus* together with the *pronator inferior*, of which at first it seems merely to constitute a part; lies under the *flexor carpi ulnaris* (No. 8) nearly as No. 6 under No. 5, but not united with it. Inserted upon the ulna beside the *ligamentum interosseum*. It is large only in the Gallinæ, but occurs also in the Anates, *Uria*, the Psittaci, and probably in some others; but is certainly wanting in *Strix*, *Pernis*, *Charadrius*, *Sterna*, *Ciconia*, *Grus*, and the Oscines. Some membranous threads, very high up, usually, however, indicate its place. It must be regarded as a continuation of the *pronator inferior* on the other side of the bone. It is called by Schöpss "*flexor profundus Gallinacearum*," which long name, in order to be quite correct, must be further increased by the word "*cubiti*." Moreover it is erroneous, as the muscle occurs in several forms.

16. *Brachialis internus* (or *Flexor antibrachialis brevis*) is far less than in man, lies in birds almost entirely on the cubitus, and passes up, on the humerus, only between the two condyles; on the ulna it goes somewhat further down near the *ligamentum interosseum*, concealed by all the flexors and under the *pronator inferior*. It terminates on the ulna near the preceding (15) when this occurs, but is in its whole development without any relation to it, and seems scarcely to vary in size.

Note.—All the short muscles (*b*) on the outer and inner sides of the cubitus seem to form together one or two inferior muscular layers, which surround the joint, and are covered by the long muscles which pass to the carpus and fingers. They might all be called "*humero-ulnares*," and seem all to have, as their original function, the holding together and flexion of the joint. They may therefore be merely developments of the capsular ligament. The near relation between the base of one pair of them and a pair of the long muscles (namely Nos. 6 & 5, Nos. 7 & 3, and Nos. 15 & 14) is to be noted.

The cubitus has no more than these 16 muscles. Of those which occur in man there are wanting therefore :—Among the *extensors*, three belonging to the thumb and one to the little finger ; among the *flexors*, one to the thumb and the *pronator quadratus* ; or all the proper long muscles of the thumb, and one which could not act. Other peculiarities of the class are :—The double pronator and the single supinator, the course of the sinews from the *flexores digitorum*, *fl. carpi radialis*, and *extensor digitorum*, the size of the *extensor carpi radialis longus* and *anconæus parvus* (? No. 6), and lastly the addition in some forms of No. 15 (*humero-ulnaris internus*). One could scarcely suppose that there would be so little difference between the muscles of the bird's wing and the human arm !

C. Muscles of the humerus, which still more resemble those of man. They are :—

17. *Extensor antibrachii* (or *triceps*), almost exactly as in man, but wanting the *caput internum*.

18. *Flexor antibrachii* (or *biceps*) as in man.

The *Anconæus parvus* has already been mentioned, No. 6 ; as also the *Brachialis internus*, No. 16.

Of the muscles of the shoulder we shall in what follows mention only the *deltoideus*, in order to avoid going into too many specialities here ; but we will nevertheless remark that equally distinct differences, as in the forearm, present themselves, between different groups of birds, in the other muscles of the shoulder and those of the trunk.

In order to make a comparison between the muscles of the arm in the orders of birds, I have myself investigated them in 27 species selected from all orders, and can, moreover, avail myself of Schöppss's excellent descriptions of 11 (four of which, however, are the same) ; namely :—

OSCINES : *Corvus corone*, Schöppss ; *Garrulus glandarius*, Sch. et ipse ; *Pyrrhula vulgaris*, *Emberiza citrinella*, *Parus cristatus*, and *Hirundo rustica*.

COCYGES (sensu latiori) : *Cypselus apus*, *Picus major*,

P. martius, and *Jynx*; *Psittacus magnus*, Gm., *P. amazonicus*, and *Columba livia*, Schöpss et ipse.

ACCIPITRES: *Strix nisoria*, *S. liturata*, *Astur palumbarius* (*Pernis apivorus*); *Aquila albicilla* and *Buteo vulgaris*, Schöpss.

GALLINÆ: *Gallus domesticus*, Sch. et ipse; *Tetrao tetrix* and *Lagopus saliceti*.

GRALLÆ: *Struthio*, *Otis*, and *Fulica*, Schöpss; *Scolopax rusticola*, *Grus*, *Charadrius pluvialis*, and *Ciconia nigra*.

NATATORES: *Anas glacialis*, *Sterna hirundo*, *Uria grylle*, and *Mormon arcticus*; *Aptenodytes*, Schöpss.

All the species enumerated furnished with a song-apparatus (*Oscines*) agree so completely in the structure of the muscles, that I can scarcely separate any except *Hirundo*. They are distinguished from the other Orders especially as follows:—

a. The bellies of the muscles are plump and rounded, and short, so that the sinews of the larger ones occupy about half, or more, of the length of the cubitus.

b. The *fascia ulnaris* is very thin, not very visible from without, and wraps round the hinder group of flexors of the forearm like an imperfect sheath. The *flexor digiti sublimis* lies upon the *flexor carpi ulnaris* in the middle beneath the *fascia*, and commences near the humerus with a short, very slender, fleshy part.

c. The hinder bundle of flexor muscles here referred to lies much further out towards the remiges in front of the ulna than in other birds, which is due to the fact that the ulna is nearly straight, with only the superior $\frac{1}{6}$ — $\frac{1}{8}$ bent upwards, and the other end still less curved in the opposite direction (therefore very slightly S-shaped). From these causes, cited under a, b, and c, a considerable space is left for the before-mentioned pits or depressions of the skin on the inner side of the cubitus.

d. The *humerus* is almost entirely clothed with muscles, which is due in part to their large size, in part and especially to the fact that the *deltoideus* goes down to the *condylus externus*, and attaches itself there near the *extensor*

radialis longus, and thus clothes the whole outer side of the bone.

In other respects the muscles are disposed in the following manner (the conditions noticed in parentheses are certainly general in the Song-birds, but not characteristic of them):—

The *extensor carpi radialis longus* is the largest of all, only $\frac{3}{8}$ fleshy, undivided, with a strong flattened sinew; the *extensor brevis* is extremely small or rudimentary; the *extensor carpi ulnaris* has a long sinew, which commences at about $\frac{2}{3}$ the length of the ulna, and terminates upon a small tubercle on the ulnar edge at the base of the third (anchylosed) *os metacarpi*. (The *extensor digitorum communis* is of ordinary form. The *extensor indicis*, from the *basis radii*, without accessory muscles in the region of the carpus.) The posterior flexors have already been described. (The *flexor digitorum profundus* starts from the *basis ulnæ*, the sinew is strong and long; the *flexor carpi radialis* from $\frac{1}{4}$ of the ulna.) The *pronatores* coalesce nearly to a single muscle, which, however, consists of two very distinct bundles, reaching to half the length of the radius. *Supinator* small, to $\frac{1}{3}$ of the radius. (*Humero-ulnaris externus* to $\frac{1}{2}$ of the ulna.)

In *Hirundo rustica* the following deviations occurred:—The *flexor digitorum sublimis* was but little smaller than the *underlying* flexor carpi ulnaris, and commenced near it on the *condylus humeri*; but the *fascia tendinea*, as usual, quite membranous, thin, &c. The two *pronatores* of the same size. All the bellies of the muscles are still shorter than usual, namely that of the *extensor carpi radialis longus* merely to $\frac{2}{3}$ of the cubitus, by which means the outer pits of the cubitus become longer in proportion. In all other respects as in other Song-birds.

The birds of other Orders which were examined showed the following points of agreement by which they are distinguished from the Song-birds:—

a. The fleshy part of the muscles is of more even thickness and is elongated below towards the *ligamentum carpi*, often

extending to the latter in the *extensor* and *flexor carpi ulnares*. Thus the sinews are short, and the arm itself acquires a uniformly thick and less elegant shape. (In those which have a very long cubitus, *Grus*, *Strix*, &c., the muscles are, however, only fleshy for $\frac{3}{4}$ or $\frac{2}{3}$ of their length.) Bony sinews occur in species of several Orders.

b. The *fascia ulnaris* is thick, strongly sinewy, flat and of uniform breadth, with definite edges which are not folded down, lying upon the surface of the muscular layer, and occupying the place of the *sinus ulnaris*. It starts from the ulna, along the whole of the bone, by a strong lamella, which separates the *flexor carpi ulnaris* from the *flexor digitorum sublimis*. The latter consequently lies on the inner (radial) side, and not in the middle upon the former; it is always attached under the *fascia tendinea*, and does not extend to the base of the cubitus; it is usually fleshy nearly to the *ligamentum carpi*.

c. The *ulna*, towards the upper extremity, is gradually curved for a considerable distance (at least from $\frac{1}{3}$ to $\frac{2}{5}$), but straight in the anterior part (consequently somewhat bowed, but not S-shaped); the condyle projects downwards a little only in consequence of its thickness. By this means the *flexor carpi ulnaris* comes to project only slightly behind the ulna.

d. The *humerus* is to a great extent uncovered, in consequence of the shortness of the *musc. deltoideus*, which in most forms reaches half the length of the humerus or is rather less, and is very narrow. Only in *Columba* does it reach $\frac{3}{4}$; in the Water-birds (*Anas*, *Sterna*, *Alca*) it is quite small.

With regard to the arrangement of the muscles the following may be remarked in general:—

The *extensor carpi radialis longus* is not larger, sometimes narrower than any of the others—*e. g.* the *flexor carpi ulnaris*, or the *extensor carpi ulnaris*, or the *pronator*, &c.

The *extensor carpi radialis brevis*, on the contrary, is large and strong (except in the Natatores).

The *extensor carpi ulnaris* is usually fleshy to the carpus, and terminates with its sinew on the underside of the middle

os *metacarpi* (i. e. on the radial side of the carpal fissure). The tubercle upon which it terminates in the Oscines is wanting.

The *pronatores* are distinctly separated, and stronger than in the Song-birds. So also with the *supinator* and *humero-ulnaris externus*; but these latter sometimes extend no further down on the cubitus than in the Song-birds (to $\frac{1}{3}$, $\frac{1}{2}$, &c.), because the cubitus is usually much longer.

The following contains a somewhat more detailed description of the muscles of the cubitus in the forms known to me other than Song-birds, exclusive of some which deviate considerably (*Cypselus*, *Picus*, Ostrich, Penguin), and which will be referred to separately.

a. On the Outer Surface.

1. The *extensor carpi radialis longus* has a nearly cylindrical but short sinew in the Raptorial birds and in *Sterna*, a flat and broad one in most others, especially the Gallinæ. The belly of the muscle often commences with two parts (*capita*), which remain separate far down in *Grus*, *Ciconia*, *Charadrius*, some of the larger Raptores, *Mergus*, &c.; but this varies in the different Orders. In *Columba* it is unusually broad at the base and commences high up on the humerus, above the *condylus externus*.

2. The *extensor carpi radialis brevis* is very large in *Psittacus*, *Columba*, the Raptorial birds, the Gallinæ, and the large Waders (also in *Otis* and *Struthio*). It commences from the *basis radii* and near the *basis ulnæ*, so that its aponeurosis forms a regular *ligamentum interosseum*, and the concealed part is as thick as one of the other largest muscles. On the other hand it is quite small, as thin as a thread, in *Charadrius*, *Anas*, *Sterna*, *Uria*, and *Alca*, commencing only from the radius; in *Grus* and *Mergus* also only from the radius, but not so thin.

3. The *extensor digitorum communis*; rather flat and broad, but thin in the Accipitres, slender in the rest. In the Ostrich its sinew gives off no branch to the thumb (see further on).

4. The *extensor indicis proprius* is generally thick; it commences near the *basis radii* in *Sterna*; at $\frac{1}{4}$ in *Psittacus*, the Accipitres, and the Grallæ; a little further down in *Columba*, at $\frac{1}{2}$ in *Aptenodytes*; and lowest down in the Gallinæ, namely at $\frac{2}{3}$ in *Gallus domesticus*, $\frac{1}{2}$ in *Tetrao*, and a little more than $\frac{1}{2}$ in *Lagopus*; at $\frac{2}{3}$ also in *Ciconia nigra*, in which it has an unusually fine sinew.

5. The *extensor carpi ulnaris* is rather thin in the Grallæ and *Sterna*, commencing by a slender sinew from the aponeurosis on the surface of the next within on the cubitus; similar, but larger and higher up towards the humerus in the Anseres, Gallinæ, and *Strix*. Fleishy nearly from the humerus in *Columba*.

6. The *humero-ulnaris externus* is thick like No. 1, and strong in all. *Columba* has it extended to half the length of the ulna, *Psittacus* to $\frac{2}{3}$. Among the Accipitres: in *Aquila albicilla* to $\frac{1}{2}$, in *Buteo*, *Falco*, and *Strix* a little further, in *Falco palumbarius* to $\frac{2}{3}$. In *Anas*, *Uria*, and *Alca* to $\frac{2}{3}$, in *Sterna* scarcely to $\frac{1}{2}$. Among the Grallæ, to $\frac{3}{4}$ in *Scolopax* and *Fulica*, but only $\frac{2}{3}$ in *Grus*, and $\frac{1}{2}$ in *Charadrius*; in *Ciconia*, in which it is thin, and lies between the two arm-bones, scarcely to $\frac{1}{2}$. It is largest of all in the Gallinæ, reaching to the end of the ulna.

7. The *supinator* is always more strongly fleshy. It extends beyond the half of the radius in *Psittacus*, to $\frac{2}{3}$ in *Columba*, to $\frac{1}{3}$ in the Accipitres and Waders, beyond the half in the Gallinæ (*Lagopus* $\frac{2}{3}$, *Gallus* $\frac{2}{3}$), to $\frac{1}{2}$ in *Anas*, to $\frac{2}{3}$ in *Mergus*, visible on both sides of the bone as in all the preceding; but in *Uria*, *Alca*, and *Aptenodytes* it goes on the outside only to about $\frac{1}{3}$. For half its length it is united with the *extensor digitorum communis* in *Charadrius*.

b. On the Inner Surface.

8. The *flexor carpi ulnaris* has already been noticed; always thick.

9. The *rector remigum* is wanting in *Aptenodytes*. It has a long stout sinew when the cubitus is long, as in *Grus*, *Strix*, &c.

10. The *flexor digitorum sublimis*.—Its fleshy part commences in *Columba* and *Psittacus* at the base of the fascia, and is attached to its margin nearly to the carpus; it is somewhat shorter, but thick in the Accipitres, commencing from $\frac{1}{4}$ of the fascia in *Strix*, *Falco palumbarius*, *apivorus*, &c., somewhat lower down in the others, and at $\frac{1}{3}$ in the Eagles. It is least of all in the Gallinæ, just under the end of the fascia (from $\frac{1}{2}$ in *Lagopus* and $\frac{2}{3}$ in *Tetrao tetrix*); the sinew gives off a branch to the *basis pollicis*, although No. 4 also furnishes one as usual. Of the Grallæ, *Scolopax* and *Grus* have it formed as in the Accipitres; *Ciconia* and *Rallus* have it smaller; *Anas* has it fleshy from $\frac{1}{4}$ to the apex of the fascia. In *Alca* it is strong, fleshy from the base to $\frac{4}{5}$ of the fascia; in *Sterna* from the base to $\frac{1}{3}$.

11. The *flexor digitorum profundus* commences in most forms from $\frac{1}{4}$ of the ulna: *Columba*, Accipitres, and Gallinæ, *Scolopax* and *Fulica*, *Anas*, *Alca*; nearer the base in *Psittacus* and *Columba*.

12. The *flexor carpi radialis* commences a little above the middle of the ulna in *Psittacus*, *Columba*, the Accipitres and Gallinæ, somewhat higher in the Water-birds, but lower down in the Waders; at $\frac{2}{3}$ in *Otis*, *Scolopax*, *Struthio*; at $\frac{4}{5}$ in *Fulica*, which therefore, has this muscle unusually small (Schöpss); but from $\frac{1}{3}$ in *Grus*, and just below $\frac{1}{2}$ in *Ciconia*.

13, 14. The *pronatores* appear under two different forms. Sometimes they are of the same length, or the lower one is a little shorter, as in the Song-birds, but always widely separated; sometimes the lower one is considerably longer and thicker. The lower one is always at least as thick as No. 1, frequently (e. g. *Grus*) twice as thick; it is largest of all in *Columba*, reaching to $\frac{5}{6}$ and to the apex of the radius. In *Psittacus* they reach to $\frac{1}{2}$ and $\frac{3}{5}$, and are at their upper attachment on the humerus more widely separated than usual, so that the upper one is attached considerably higher up on the bone, near the *flexor carpi ulnaris*. In the Accipitres they usually extend to $\frac{1}{3}$ and $\frac{3}{5}$ (*Strix nisoria*, *Astur*, *Buteo*), or $\frac{1}{3}$ and $\frac{1}{2}$ (*Falco*, *Strix liturata*), or only to $\frac{1}{4}$ and $\frac{1}{2}$ (*Aquila albicilla*).

In the Gallinæ the upper one is somewhat longer and reaches to $\frac{3}{5}$ in *Tetrao*, $\frac{2}{3}$ in *Lagopus*, beyond $\frac{3}{4}$ in *Gallus*. The Grallæ show both forms; in *Scolopax* both extend to $\frac{1}{2}$, in *Ciconia* and *Grus* to $\frac{1}{3}$ and $\frac{2}{5}$, in *Otis* to $\frac{1}{2}$ and $\frac{2}{3}$, and in *Fulica* to $\frac{1}{2}$ and $\frac{3}{4}$. Among the Water-birds: in *Sterna* to $\frac{1}{4}$ and $\frac{2}{5}$; in *Anas* to $\frac{1}{2}$ and $\frac{2}{3}$; in *Alca* and *Uria*, in which they extend $\frac{1}{3}$ and $\frac{3}{4}$, the larger one lies externally towards the apex of the cubitus, and not under the shorter one, as it does in all other birds, or at least in a great majority of them.

15. The *humero-ulnaris inferior* has also been already mentioned. It extends in the Gallinæ to half the cubitus, where it meets with the commencement of No. 13 on the inside of the ulna and terminates at the outer margin of the latter. In *Cygnus* it was found by Tiedemann. In *Anas glacialis* and *mollissima* it starts from the condyle as a peculiar, cylindrical, and fleshy bundle, attached at $\frac{1}{4}$ of the ulna beside the *brachialis internus* and the *flexor digitorum profundus*. In *Mergus merganser* just the same, but less distinctly defined. In *Uria* it is not separated, but is represented by a part of the *pronator inferior*, the fibres of which are attached to the ulna from its base to $\frac{1}{4}$ of its length. In *Psittacus* it forms a very small bundle, issuing from the condyle under the *pronator inferior*, and is only loosely attached by cellular tissue to the upper $\frac{1}{7}$ of the ulna.

Possibly a rudiment of it has been overlooked in some of the other birds described, which I have now no opportunity of examining afresh; but it is certainly deficient in *Strix*, *Pernis*, *Grus*, *Ciconia*, *Charadrius*, and *Sterna*.

Bony sinews occur most irregularly,—e.g. among the Gallinæ: in *Gallus domesticus* only in the *flexor digitorum profundus* externally on the hand, but not in any in the forearm; in *Lagopus* in the forearm in the *extensor digitorum communis* and *extensor indicis*, but no more. Among the Grallæ: in *Otis* in the *flexor digitorum profundus* (Schöppss), but in *Grus* in all the *musculi carpi et digitorum* (*extensores* and *flexores*) on the cubitus, except in the *extensor indicis* (the *extensor carpi radialis longus* is bifid, with one soft and one bony sinew). Of the Accipitres, *Strix liturata* has bony sinews

on the cubitus in all the *musculi digitorum et carpi* except the *flexor carpi ulnaris*.

As the result of this exposition it appears that all these birds, notwithstanding their very considerable differences, agree in the general structure of the muscles of the cubitus, and only seem to present occasional differences, owing to which the orders are difficult to characterize.

The Gallinæ, however, appear to show definite peculiarities, namely:—(a) the two *humero-ulnares* are unusually developed: the inner one, which is almost peculiar to them, extends to $\frac{1}{2}$, and the outer one to the apex of the ulna; (b) the *flexor digitorum sublimis* is unusually small and shifted outwards; (c) the *extensor indicis proprius* commences far down (which, however, is also the case in *Ciconia*).

The other orders seem to vary more; but they nevertheless distinctly group themselves around the Gallinæ, and very closely resemble each other. From the few well-known examples they are difficult to characterize; but it must be remarked that the Raptorial birds known to me have cylindrical sinews to the most anterior muscles, a shorter *pronator superior*, a broader *extensor digitorum communis*, &c.

The Waders have a weak *extensor carpi ulnaris*, which commences upon the *humero-ulnaris externus*, but they vary much.

The Water-birds have a very small *extensor carpi radialis brevis* and *deltoideus*, but present three quite different forms: *Sterna* and the Ducks with a more ordinary external form, the latter with a small separate *humero-ulnaris interior*; and the Pygopodes with the wings much flattened, and, in consequence, an unusual appearance of the muscles and an unusual position of the *pronatores*; the *supinator* lies only on the outer side, the *fascia ulnaris* is closely attached to the ulna without any interspace, &c.

I can least of all pronounce an opinion upon the Coccoyges, as only a few of the more aberrant forms of that order are known to me, and at present I have no opportunity of making up this deficiency. They seem, however, nearly to approach the Accipitres.

We pass on now to a short description of the muscles in some isolated forms which are the most aberrant that I know of.

Cypselus has appeared to me to show a single agreement with the Song-birds, namely, in the extremely small *extensor carpi radialis brevis*. It further resembles *Hirundo* only in having a *flexor digitorum sublimis*, which is nearly as large as the *flexor carpi ulnaris* and commences from the *condylus internus*; but these muscles are not placed as in the Swallow and the Oscines generally, but as in the non-Song-birds, the former being situated quite on the radial side of the latter, separated therefrom by the continuation of the *fascia tendinea*, which is distinctly of equal breadth. Moreover the bellies of the muscles are not rounded, but rectilinear, and continue fleshy nearly to the carpus. The non-Song-bird type is therefore completely retained, but in other respects the course of the muscles is very different.

The *extensor carpi radialis longus* is unusually broad, and commences above at $\frac{1}{2}$ the humerus; the *extensor digitorum communis* is also unusually broad at the root; the *extensor indicis* small, otherwise as usual; the *anconeus parvus* as usual, to $\frac{1}{2}$; the *flexor digitorum profundus* inserted on the *condylus internus humeri*! and nearly as large as the *extensor carpi radialis longus*; course of the sinews as usual. The *flexor carpi radialis* commences near the base of the ulna. The *pronatores* are very strong, the upper one something more than $\frac{1}{2}$, the lower one rather over $\frac{3}{4}$, contracted at the apex, not dilated! The *supinator* to $\frac{1}{2}$.

Picus agrees in most respects with the Song-birds, so that we need only indicate the differences, all of which show an approximation to the non-Song-birds. They are as follows:—

a. The *pronator inferior* has an unusual structure, which I have seen elsewhere only in *Pernis apivorus*; for it is attached to the *membrana interossea* and to the ulna just as much as to the radius (in one specimen of *Picus major* it was only attached to the ulna; but in two others, and in *P. martius*, was as just mentioned); it extends somewhat beyond $\frac{1}{2}$ of the

cubitus. The *pronator superior* is distinctly separated and somewhat longer; the *supinator* also rather beyond $\frac{1}{2}$.

b. The bellies of the muscles are less convex and rather longer than in the Oscines, in consequence of which the pits on the forearm are shorter. To this it is due that the *flexor carpi radialis* commences far down, at $\frac{2}{5}$.

c. The curvature of the *ulna* is somewhat longer (to $\frac{1}{4}$) at the upper extremity, inconsiderable at the anterior extremity; whence follows a position of the posterior flexors which begins to differ somewhat from that in the Song-birds.

d. The *fascia ulnaris* is filiform, although a distinct streak. The *flexor digitorum sublimis*, which is attached to it, is like that of the Song-birds in *Picus major*; but in *P. martius* it has a much more elongated belly; it goes to $\frac{2}{3}$ of the cubitus and commences a little way from the humerus.

e. The *deltoideus* is much smaller than in the Oscines, only to $\frac{3}{4}$ of the humerus.

Jynx torquilla resembles *Picus*: but both *pronatores* are inserted on the radius, the superior at $\frac{3}{5}$, the inferior at $\frac{1}{2}$. They are much stronger than in the Oscines and more distinctly separated. The *flexor digitorum sublimis* is much thicker than in the Song-birds, fleshy for $\frac{3}{4}$ of its length, and placed beside the *flexor carpi ulnaris*. The *extensor carpi radialis brevis* as in the Song-birds.

Columba, which has been referred to in the general description, presents nearly equal peculiarities in its broad *extensor carpi radialis*, its enormously large *pronatores*, &c. It has, further, an unusually constructed muscular apparatus within the fold of skin in front of the humerus.

The *Ostrich*, according to the description given by Schöppss, has many peculiarities, and therefore the following extract may be given:—

The *extensor carpi radialis longus* commences high up on the humerus, at $\frac{5}{8}$.

The *ext. carpi rad. brevis* is as in the Grallæ &c.

The *ext. digitorum communis* has no sinew to the thumb.

The *ext. indicis*, from $\frac{1}{3}$ of the radius, has many accessory muscles.

The *ext. carpi ulnaris* is half united with the *humero-ulnaris externus*, which extends to $\frac{2}{5}$.

The *supinator* strong, to $\frac{3}{5}$.

The *flexors* nearly as in the Waders &c., but the sinew of the *flexor digit. profundus* gives off a branch to the thumb, instead of the *ext. digit. comm.*

The *pronator* is single, to $\frac{3}{5}$.

The *biceps* has only the *caput longum*.

The *deltoideus* also arises from the clavicle, and therefore more resembles that of the Mammalia ; it terminates at $\frac{2}{3}$ of the humerus.

The *tensor plicæ cutaneæ* and *rector remigum* occur, notwithstanding the undeveloped state of the wing.

Aptenodytes, next to the Ostriches, is the most aberrant of all known forms of birds, and therefore the following abstract, also from Schöpp's description, may be of interest in this place. The wing is perfectly formed, as in birds, and only in its external form and strong compression has it some resemblance to the pectoral fin of a whale, shark, &c.

The *extensores carpi radiales longus et brevis* are nearly as usual, the latter not small.

The *extensor digitorum communis* gives off at the carpus a branch to the *extensor indicis proprius*.

Of the *extensor carpi ulnaris* there remains only a rudiment of sinew-fibres.

The *humero-ulnaris externus* is small.

The *supinator* to $\frac{1}{2}$; as in *Alca*, only on the outer side of the radius.

Of the two *pronatores* only sinewy rudiments.

The *flexor carpi ulnaris* seems to consist only of a sinew (perhaps the *fascia ulnaris* ?), and the *rector remigum* is wanting. On the other hand the *flexor digitorum sublimis* commences from the condyle, and its sinew terminates on the second phalanx.

The *flexor digitorum profundus* is not small ; also from the radius.

The *flexor carpi radialis* consists only of a few sinewy fibres, as also the *flexor* and *extensor ulnares*.

The *biceps* is wanting, but the *brachialis internus* passes higher up.

The *deltoideus* is very small.

The *tensor plicæ cutaneæ* occurs, although the wing can bend but little.

CONCLUDING REMARKS.

From what precedes, it appears distinctly that, as regards the external and internal structure of the wing, the Song-birds show a remarkable uniformity. They do the same in all other respects, and it is only necessary to add to the differences from other birds here enumerated, the muscular apparatus of the lower larynx, which is peculiar to them, in order to prove clearly that they constitute a definite and peculiar group in the class of Birds, scarcely containing any transitional forms. That, however, the so-called "song-muscles" must be regarded as the expression of a peculiarity in the whole organization, and not merely as a singing-apparatus, is shown distinctly by the fact that they occur in all the species constructed in a certain way, of which a great part do not possess anything that can be called "song;" *e. g.* the *Corvi*, *Garruli*, and a number of exotic forms, as also the *females* which do not sing. Moreover there is a true song in many species which are destitute of the above-mentioned muscles; for example, in the Diving-ducks, a few Accipitres, the domestic fowl, *Coturnix*. The "play" of the Tetraones, the cry of *Meleagris*, the peculiar sounds produced during the breeding-season by *Perdix*, *Scolopax*, and many Tringariæ, are essentially exactly the same as the song of the small birds.

It is equally easy to see distinctly that the Water-birds in all respects constitute the most divergent contrast to the Song-birds, and that the Waders and Gallinæ are joined with them, these three orders closely agreeing in most particulars.

The Accipitres, indeed, at the first glance, seem to present much difference by reason of their large wings; but if we accurately compare them, it is found that these wings scarcely differ in any respect from those in a considerable

number of the Waders and Water-birds, which also have long wing-bones and remiges (e. g. *Ciconia*, *Ardea*, *Larus*), and that their whole structure and feathery covering is exactly the same as in the three orders above mentioned. It is unnecessary to cite examples of this, as they occur upon every one of the preceding pages. If other parts of the body are taken into consideration, we always find in the fundamental form the same definite divergence from the Song-bird type, and agreements with the Gallinæ, Waders, and Water-birds. The Accipitres and the Gallinæ appear as two modifications of the same form, developed in different directions; the latter, both externally and internally constructed to feed on vegetable diet, with a strongly muscular stomach adapted in other respects thereto, with a large cæcum, with beak and claws not very acute, with no need of strong flight, &c.; the former converted into an animal of prey, with a thin stomach and in general a smaller intestine, with stronger organs of capture, and especially a great power of flight. But the near affinity between them appears distinctly in the downy covering, the arrangement of the feathers, the structure of the arm, the whole construction of the feet, and even in the form of the beak and claws in the Vulturini and a great number of the American species of *Buteo* and *Aquila*, when compared with those of the Gallinæ. Like the next forms, however, the Raptorial birds approach the Song-birds by a greater development of the posterior toe, and also by the incomplete structure of the young and the necessity of feeding them. The hinder toe, however, never acquires the form which alone belongs to the Song-birds, but always retains the same type as in the preceding, and is somewhat elevated at the root.

The remaining forms of birds (the Doves, Parrots, Cuckoo-like birds, and Pici) range themselves with the exception of the last named, just as distinctly, with the same great division of the class; but also show, besides the peculiarities just mentioned, some further resemblances to the Song-birds, in the generally smaller number of the arm-remiges, and the smaller number of rows of the inferior coverts. Their

colours also, the external aspect of the bill and feet (but certainly not their structure), their smaller size and residence in trees, cause one to fancy that they are like the Song-birds, with which they have constantly been confounded. The case is different with *Picus*, for this genus appears to be a true transitional form, which, from its wing-structure, seems most to resemble the Song-birds; but its want of the song-muscles, the structure of its feet, and the arrangement of the muscles of the wing, in combination with the above-mentioned character of the small outer coverts, determine most distinctly its place to be among the Cuckoo-like birds.

We have here endeavoured to show that although there are manifold and considerable differences between the birds which are destitute of the song-apparatus, nevertheless they all possess a decided similarity of organization, owing to which they can and must be grouped together as a single great division of the class, in opposition to the Song-birds, which have another very distinct fundamental structure, but which present a very remarkable uniformity. This binary division is therefore the first natural division of the class of Birds; the Song-birds must stand at one end of the series, and next to them come the Pici, Coccyges, &c. The other end is necessarily occupied by the Natatores. The Accipitres and Gallinæ must retain their place in the middle of the series, which, however, certainly does not prevent our regarding them as the most highly developed, if we choose to do so.

I have already developed these same views of the affinities and scientific arrangement of the forms of birds in my "Ornithologiska System," published in 1835 in the Kongl. Vet.-Ak. Handl. and they have only been strengthened by a continued investigation, although many alterations in the more special groupings have been rendered possible by an enlarged knowledge.

In order to give a summary of the more important of these alterations the following Appendix is provided.

APPENDIX I.

Systematic Arrangement *.

In order to avoid too many degrees of division we shall only remark here that the so-called *Song-birds* alone are included in the undermentioned Legio prima; and that all the others, which constitute Legiones secunda, tertia, and quarta, have not five pairs of muscles to the lower larynx. The differences in structure of these two chief divisions have been copiously referred to in what precedes, as also in the often cited "Ornithologiska System" in Vet.-Acad. Handl. for 1835.

If, with the view of obtaining greater symmetry in the arrangement, it be desired to retain the binary division in accordance with the nature of the hinder toe and the young, adopted in the place just cited and by many authors, we get the first two "Legiones" together in one, and the last two in the other division; but we are then compelled to remark (as I have done, *loc. cit.* p. 67) that the species belonging to the Legio secunda resemble those of Legiones tertia and quarta in the principal parts of their structure, but not those of the Legio prima with which they are arranged. It must also be remarked that the hinder toe in a Raptorial bird, a Cuckoo, or even a *Picus* is never so large or formed in the same way as in a Song-bird; it is always narrower at the base, a little raised, &c., and approaches the form of that in the Gallinæ, Waders, and Water-birds; and, further, that many genera with long supporting hinder toes occur in both the great divisions, which usually have it small and uplifted, namely, *Penelope*, the whole cohort of the Herodii (*Ardea*), and the whole Order Totipalmes.

Legio prima ("VOLUCRES," Vet.-Acad. Handl. 1835).

Constitutes only the Ordo prima †.

* [It will be of course recollected by our readers that this arrangement was in considerable degree modified by the author in his 'Tentamen' (187—?).—ED.]

† The divisions which are here cited immediately under the Orders correspond exactly to those which are called "Zunft" by Oken, which

1. PASSERES (Nares plumis tectæ, carent membrana).
 - a. (Integrirostris) : Ploceinæ ; Serininæ ; Loxiæ.
 - b. (Incisirostris) : Fringillinæ ; Pitylinæ ; Emberizinæ.
2. OSCINES.
 - a. (Membr. narium fornicata, nuda).
 - *(Alæ mediocres) : Sturninæ ; Alaudinæ ; Turdinæ
(cum *Sylvii*s et *Cinco*).
 - *(Brevipennes) : Myotherinæ ; Timaliinæ ; Maluri ;
Anabatinæ.
 - *(Longipennes) : Hirundininæ.
 - b. (Membr. narium obsoleta, plumosa).
 - *(Depressirostris) : Muscicapinæ ; Tyranninæ (cum *Platyrhyncho*, *Euscarthmo*, &c.).
 - *(Compressirostris) : Laniinæ (cum *Thamnophilis*) ; Garuliniæ ; Corvinæ ; Paradiseæ ; Tanagrinæ ; Parinæ.
 - *(Syndactylæ) : Piprinæ ; Eurylaimi.
3. LONGILINGUES (Omn. membr. narium fornicata).
 - Gymnopinæ ; Meliphaginæ ; Cinnyrinæ ; Dacnidinæ.
4. SCANSORES (Ungue medio non obliquo &c.).
 - a. (Membr. narium fornicata) : Certhiaceæ.
 - b. (Membr. narium obsoleta, plumosa) : Dendrocopinæ ;
Sittinæ.

Legio secunda ("GRESSORES," *loc. cit.*).

Ordo 2. COCCYGES.

1. PICIDÆ : *Picus*, *Jynx*.
2. CUCULIDÆ : Bucconinæ (cum *Rhamphasto* et *Galbula*) ; Cuculinæ ; Trogoninæ.
3. SYNDACTYLÆ : Alcedinidæ (et *Merops*) ; Coraciinæ ; Musophaginæ (cum *Colio*).
4. MACROCHIRES, Nitzsch : Caprimulginiæ ; Cypselinæ ; Trochilinæ.
5. COLUMBÆ.

term may be translated "cohors." They are larger than the "Familie" of recent writers, but do not represent such considerable peculiarities of form as the Linnean *Ordines*.

6. PSITTACI: Loriinæ; Androglossinæ; Plectolophinæ; Sittacinæ; Pezoporinæ.

Ordo 3. ACCIPITRES.

1. NOCTURNI: Striginæ.
2. DIURNI: Falconinæ, &c.....; Aquilinæ; Vulturinæ.

Legio tertia ("CURSORES").

Ordo 4. GALLINÆ.

1. PENELOPINÆ: *Penelope*, *Crax*.
2. GALL. PROPRIÆ: Phasianinæ; Tetraoninæ; Pteroclinæ; Crypturinæ.

Ordo 5. STRUTHIONES.

1. *Struthio*, Linn.
2. *Apteryx*.

Ordo 6. GRALLÆ.

1. ALECTORIDES: Otidinæ; Palamedeinæ; Gruinæ; Rallinæ.
2. LIMICOLÆ: Thinocorinæ; Charadriinæ; Tringariæ.
3. PELARGI, Nitzsch: Ciconinæ (? *Phænicopterus*).
4. HERODII: *Ardea*, *Cancroma*.

Legio quarta ("NATATORES").

Ordo 7. ANSERES.

1. *Anas*, Linn. ——— ——— ———.

Ordo 8. GAVIÆ.

1. LONGIPENNES: *Sterna*, *Larus*.
2. TUBINARES: *Diomedea*, *Procellaria*, *Haladroma*.

Ordo 9. STEGANOPODES.

TOTIPALMES, Auct.

Ordo 10. PYGPODES.

1. EUDYTÆ: *Podiceps*, *Colymbus*.
2. URIÆ et ALCÆ.
3. APTENODYTINÆ.

APPENDIX II.

Synopsis of the number of Arm-remiges.

Of the figures which are given below, the first always indicates the number of the arm-remiges which appear nearly alike in structure and size, and in this number the first is always included. The last number always indicates the last, decidedly shorter feathers. Where three figures occur, the middle one denotes those which, without being abbreviated, possess a decidedly different form; and such occur nearly always when the posterior remiges differ considerably (difformes). The figures placed within parentheses show the whole number, and when this stands alone it is generally copied from Nitzsch's 'Pterylographie,' for the purpose of obtaining a more complete view.

In the greater part of the Song-birds the number is definitely 9. All that are known to possess a greater number (about 12 genera) are cited in the following table; in these and all which have more than 9, the number appears to be subject to a little variation—for example, in *Corvus cornix* I have twice found 11. In the Waders and Water-birds it appears that the variation may amount to 2 or 3, without relation to the moulting. This subject deserves to be particularly investigated; possibly the number is not variable.

PASSERES in general	6+3	(9)
Fringilla coelebs, Pyrgita, Emberiza	6+1+2	"

OSCINES.

Sturnus vulgaris	7+2	,
Psarocolius, <i>Wagl.</i>	"	"
Gracula, sec. Nitzsch .....	....	"
Alauda, Motacilla, Anthus	6+1+2	"
Turdi	7+2	"
Saxicola rubetra	7+2	"
—œnanthe	6+1+2	"
Sylvia phœnicurus, &c.	6+1+2	"
—rubecula	5+4	"
Cinclus	6+3	"
Troglodytes	6+3	"
Menura	7+4	(11)

OSCINES (*continued*).

Hirundo	7+2	(9)
Muscicapa atric. et grisola	6+1+2	"
Chasmorhynchus .....	....	(10)
Coracina	7+3	"
Lanius collurio	6+1+2	(9)
— excubitor	7+2	"
Ampelis garrulus	7+2	"
Ocypterus	8+2	(10)
Thamnophilus striatus .....	....	"
Pica melanoleuca	6+3	(9)
— fuliginosa (sec. Nitzsch) ....	....	(10)
— azurea (do.) ....	....	"
Barita .....	....	"
Ptilonorhynchus holos.	9+5	(14)
Corvus corax, frugilegus	8+3	(11)
— cornix, monedula.	7+3	(10)
Caryocatactes	7+3	"
Paradisæa apoda (a prima gradatæ) ....	....	"
Epimachus .....	....	"
Parus major, ater	5+4	(9)
— cristatus, caudatus	3+6	"
Regulus	4+5	"
LONGILINGUES, Cinnyris	7+2	(9)

SCANSORES.

Certhia familiaris	5+4	(9)
Sitta europæa	6+3	"

COCYGES.

Picus major, tridactylus	7+3	(10)
— martius, viridis	7+4	(11)
Jynx	6+1+3	(10)
— Bucco cyanocollis	7+4	(11)
Lypornis tenebrosa	8+3	"
Rhamphastos, <i>Linn.</i>	8+5	(13)
Galbula .....	....	(10-12)
Cuculus canorus	7+2	(9)
Centropus; Eudynamis	"	"
Coccyzus; Crotophaga .....	....	(10)
Trogon narina	8+2	"
— Alcedo ispida	8+3	(12)
Halcyon .....	....	(14)
Merops viridis	10+1+2	(13)
Coracias	9+1+3	(13)
Prionites	6+5	(11)

COCYGES (*continued*).

Buceros	(9+3 or 6+6)	(11-17 Nitzsch)
Upupa epops	7+3	(10)
Musophagæ .....	....	(12-13)
Colius .....	....	(9)
— Columba turtur, œnas, palumbus .	8+1+3	(12)
— livia	8+3+3	(14)
— coronata .....	....	(15)
Caprimulgus europæus	10+3	(13)
Podargus gigas (sec. Nitzsch)....	....	(11)
Cypselus	6+2	(8)
Hemiprocne .....	....	(6)
Trochilus	4+2	"
— Psittacus domicella .....	....	(11)
— (Trichoglossus) .....	....	"
— amazon. et leucoceph.	10+3	(13)
— magnus	"	"
— erithacus (14 Nitzsch)	"	"
— menstruus .....	....	(12)
— pullarius .....	....	(10)
Calyptorhynchus	10+2	(12)
Plectolophus .....	....	(13)
Sittace macao (13)	11+3	(14)
— sp. minores .....	....	(11)
Palæornis torquatus	9+3	(12)
Platycercus	8+3	(11)

ACCIPITRES.

Strix flammea .....	....	(14)
— otus, brachyotus	11+2	(13)
— lapponica, liturata	11+3	(14)
— aluco	"	"
— tengmalmi, scops	10+3	(13)
— bubo (19 Nitzsch)	14+4	(18)
— lactea, nyctea (do.) .....	....	....
— noctua, nisorina	12+3	(15)
— asio .....	....	(12)
— passerina, <i>Linn.</i>	10+3	(13)
Falco subbuteo	11+3	(14)
— tinnunculus	11+2	(13)
Astur palumbarius	11+3	(14)
— nisus	11+2	(13)
Pernis apivorus	"	"
Circus .....	....	(14)
Buteo vulgaris	13+2	(15)

ACCIPITRES (*continued*).

<i>Aquila chrysaetos</i>	13+4	(17)
— <i>albicilla</i>	15+3	(18)
<i>Pandion haliaetos</i>	16+3	(19)
<i>Polyborus aterrimus</i> .....	....	(12)
<i>Gypaetos barbatus</i>	18+3	(21)
<i>Vultur fulvus</i>	22+4	(27)
— <i>cinereus</i> .....	....	(25)
<i>Cathartes gryphus</i>	23+3	(26)
— <i>papa</i> .....	....	(22)
<i>Neophron monachus</i> .....	....	(18)

GALLINÆ (*obs. prima brevis*).

<i>Meleagris, Pavo</i> .....	....	(18)
<i>Phasianus, Lophophorus</i> .....	....	(16)
<i>Gallus bankiva</i> .....	....	(14)
— <i>domesticus</i>	1+9+5	(15)
<i>Numida</i> .....	....	(14)
<i>Cryptonyx</i> .....	....	(12)
<i>Tetrao urogallus</i>	1+14+5	(20)
— <i>tetrix</i>	1+12+4	(17)
<i>Lagopus saliceti</i>	1+12+3	(16)
— <i>alpina</i>	1+12+4	(17)
<i>Perdix petrosa, cinerea</i>	1+10+3	(14)
— <i>coturnix</i> .....	....	(12)
<i>Pterocles</i> .....	....	(18)
<i>Crypturus</i> .....	....	(16)
<i>Penelope</i> .....	....	(13-15)

GRALLÆ.

<i>Otis tetrax</i>	12+2+6	(20)
— <i>afra</i>	11+5+3	(19)
<i>Palamedea</i>	14+3	(17)
<i>Psophia</i> .....	....	(14)
<i>Grus cinerea</i> (23 Nitzsch)	16+4+4	(24)
— <i>Fulica atra</i>	9+3+5	(17)
<i>Rallus crex</i>	9+1+4	(14)
— <i>aquaticus</i>	7+3+2	(12)
— <i>Scolopax rusticula</i>	12+4	(16)
— <i>gallinula</i>	10+2+2	(14)
<i>Tringa maritima</i>	10+2+2	(14)
— <i>ferruginea</i>	”	”
<i>Phalaropus rufus</i>	10+2+1	(13)
<i>Totanus calidris, ochropus</i>	11+2+2	(15)
— <i>glottis, fuscus</i>	11+3+3	(17)

GRALLÆ (*continued*).

<i>Limosa meyeri</i> , rec.	12+3+2	(7)
<i>Numenius arquata</i>	15+2+3	(20)
— <i>phæopus</i>	14+2+3	(19)
<i>Rhynchæa</i> .....	....	(10)
<i>Recurvirostra avoc.</i>	14 ?	(20 Nitzsch)
<i>Hæmatopus</i>	16+3	(19)
<i>Charadrius cantianus</i>	10+3+3	(16)
— <i>morinellus</i> , minor.....	"	"
<i>Thinocorus</i> ; <i>Glareola</i>	"	"
<i>Streptilas interpres</i>	10+2+4	(16)
<i>Vanellus cristatus</i>	14+2+3	(19)
<i>Œdicnemus</i> .....	....	"
<i>Phœnicopterus antiq.</i>	24+3	(27)
<i>Ciconia nigra</i>	18+3	(21)
— <i>argala</i> .....	....	(26)
<i>Anastomus</i>.....	....	(17)
<i>Scopus</i> .....	....	(16)
<i>Ibis</i> (16–20 Nitzsch).....		
<i>Ardea cinerea</i>	16+3	(19)
— <i>sp. minores</i> .....	....	(15)
<i>Cancroma</i> .....	....	(12)

ANSERES.

<i>Cygnus musicus</i>	21+2	(23)
— <i>olor</i>	18+3	(21)
<i>Anser leucopsis</i>	15+1+3	(19)
— <i>albifrons</i>	14+1+3	(18)
<i>Anas tadorna</i>.....	....	(20)
— <i>penelope</i> , <i>acuta</i> ♂ ♀	10+3+2	(15)
— <i>glacialis</i> , <i>fusca</i>	10+2+3	"
— <i>clangula</i> , <i>nigra</i>.....	....	"
— <i>marila</i> .....	....	"
— <i>molliss.</i> , <i>spectab.</i> , ♂ perf. ..	9+4+4	(17)
— " " ♀ perf. ..	11+3+3	"
<i>Mergus albellus</i>	10+3+3	(16)
— <i>serrator</i>	11+3+3	(17)
— <i>merganser</i>	12+3+3	(18)

GAVIÆ.

<i>Sterna arctica</i>	13+5	(18)
— <i>hirundo</i>	16+2+2	(20)
— <i>caspia</i>	20	(20)
— <i>minuta</i> .....	....	(16)
<i>Larus glaucus</i> , <i>fuscus</i>	20+2	(22)
— <i>marinus</i>	20+3	(23)

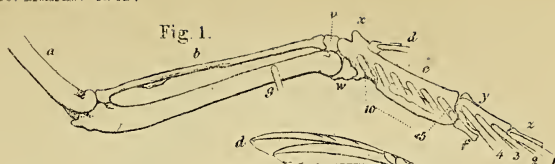


Fig. 1.

Fig. 3.



Fig. 2.

Fig. 4.

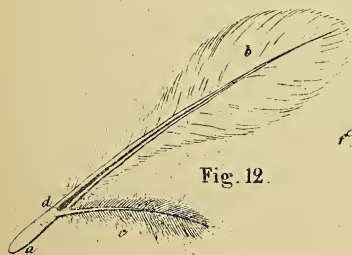


Fig. 12.

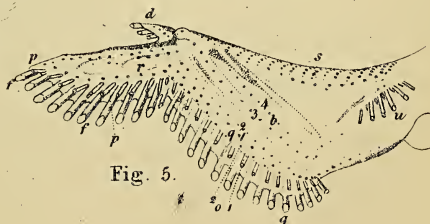


Fig. 5.

K. Vet. Ac. Handl. 1843.

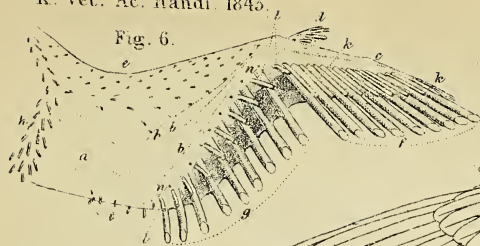


Fig. 6.

Fig. 7.

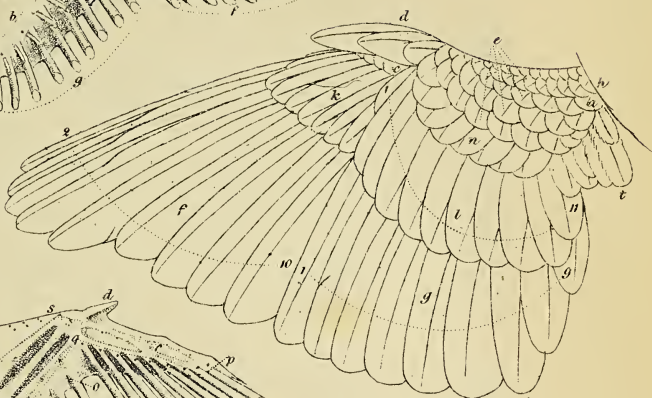


Fig. 9.

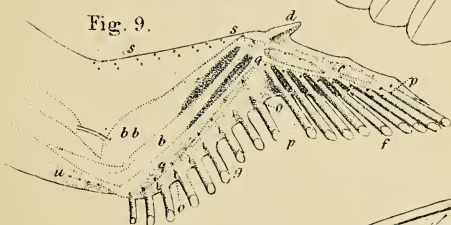


Fig. 8.

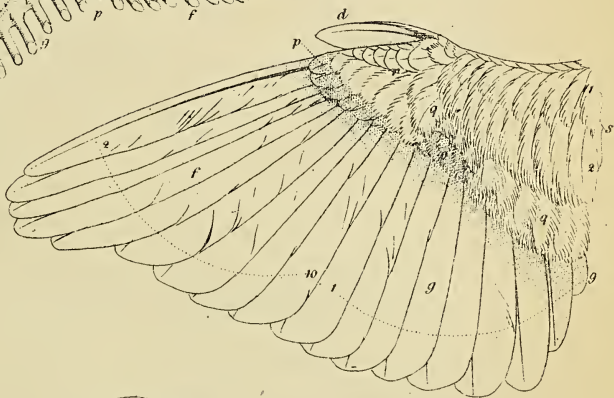


Fig. 8.o



Fig. 11.

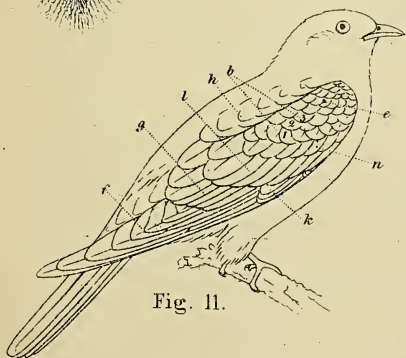
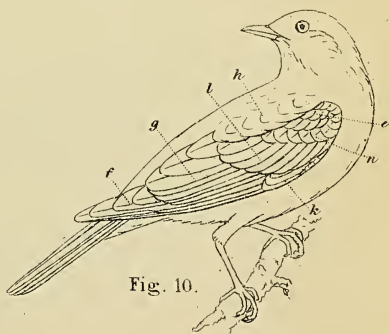


Fig. 10.



GAVIÆ (*continued*).

Larus canus	18+2	(20)
— eburneus	17+3	"
Lestris parasitica (19+3?).....	18+2	"
Procellaria glacialis	"	"
— pelagica	11+2	(13)
— gigantea .....	....	(30)
Diomedea exulans (40 Nitzsch) ..	36+2	(38)

STEGANOPODES.

Pelecanus .....	....	(29)
Tachypetes.....	....	(24)
Dysporus sula .....	....	(28)
Plotus.....	....	(16)
Graculus carbo	18+3	(21)
— cristatus	13+2	(15)

PYGOPODES.

Podiceps crist. et rubric. (16+1?)	17+3	(20)
Colymbus arcticus	20+3	(23)
— septentrionalis	19+3	(22)
Alca alle; A. pica, <i>Linn.</i>	13+3	(16)
Mormon arcticus	13+2	(15)
Uria grylle..... (11+8; 12+6)	14+3	(17, 19)
— troile	14	
Alca torda	17+3	(20)

XL.—*Note on the Nestling Plumage of Gypoictinia melanosternon* (*Gould*). By JOHN HENRY GURNEY.

IN 'The Ibis,' 1884, at p. 465, will be found some particulars respecting that very rare Raptorial bird *Gypoictinia melanosternon*, which were communicated to me by Mr. K. H. Bennett.

The Norwich Museum has recently received from this gentleman a fledged nestling of this species, taken from the nest near Mossgiel, in New South Wales, on the 6th of December, and supposed by Mr. Bennett to be "between two and three months old."

The following is a description of this specimen, which I am desirous of recording, as, so far as I am aware, no account has previously been given of the first plumage of this species,